



Life Sciences

WATER QUALITY, CIRCULATION PATTERNS
AND SEDIMENT ANALYSIS OF
THE ESTERO BAY ESTUARINE SYSTEM, 1986

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WATER QUALITY, CIRCULATION PATTERNS AND SEDIMENT ANALYSIS
OF THE ESTERO BAY ESTUARINE SYSTEM, 1986

By

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WATER QUALITY, CIRCULATION PATTERNS AND SEDIMENT ANALYSIS
OF
THE ESTERO BAY ESTUARINE SYSTEM, 1986

By: Roger S. Clark

ABSTRACT

The Lee County Department of Community Development conducted in 1986 analyses of physical-chemical parameters, circulation patterns and bottom sediments from Estero Bay. The major focus of this study was analyzation of bottom sediments for trace metals, nutrients, pesticides and PCBs. Baseline data for these parameters has been established by this study. Continued data collection will be necessary to allow conclusions to be made regarding contamination of the Bay.

This report presents data collected in 1986 and includes maps containing parameter levels, and tables containing the data. The purpose and scope of the study is explained and the results of the analyses are discussed. Methods of sample analysis and collection as well as quality assurance and control are also explained.

EXECUTIVE SUMMARY

Samples from selected sites were taken from Estero Bay by the Lee County Environmental Laboratory in 1986. The water column was sampled for typical physical-chemical parameters including nutrients and dissolved oxygen. A circulation study using non-toxic dye was performed to determine the primary direction of water flow from the major tributaries through the estuary. Bottom sediments were analyzed for trace metals, nutrients, pesticides and polychlorinated biphenyls (PCBs).

Selected water column and bottom sediment parameters were compared to the recent report "Water Quality of the Charlotte Harbor Estuarine System, Florida, November 1982 through December 1984". This report, prepared by the United States Geological Survey, presents data from the first two years of this seven year study.

Values for orthophosphorus, total nitrogen and nitrite-nitrate were similar in Estero Bay in 1986 to those in Charlotte Harbor in 1982-84. Values for dissolved oxygen had more of a range than the average values reported in the USGS study.

The circulation study provided a general interpretation of the effect of the Bay's tributaries on circulation within the Bay. Water from Hendry-Mullock Creeks and the Estero River appeared to flow towards Big Carlos Pass, which corroborates an earlier theory that the Bay is hydrologically divisible into two major regions.

Water from Spring Creek appeared to flow north and then west towards New Pass. Water from the Imperial River appeared to flow through Fish Trap Bay and through Hogue Channel northward.

Residency of water from the tributaries appeared to be at least several days within the Bay. Comparison of bottom sediment concentrations from Estero Bay with those from Charlotte Harbor provided the general conclusions that ranges for aluminum, lead, cadmium and mercury were similar. Chromium, copper and zinc had higher levels in Estero Bay in 1986 than those in Charlotte Harbor in 1984.

The concentration levels of pesticides and polychlorinated biphenyls (PCBs) were all below minimum detection limits. The variation in minimum detection limits for the data are related to the percent solids, response factors and the methodology used.

The Lee County Environmental Laboratory plans to expand the scope of the South Estero Bay (Big Hickory Pass area) monitoring program both in area covered and parameters sampled to allow continual comparisons to be made to at least some of the data contained in this study.

INTRODUCTION

Previous studies in Estero Bay Aquatic Preserve have examined ecological and water column conditions (Tabb et al 1971), (Balogh et al, 1977); productivity (Environmental Science and Engineering, Inc., 1978); inlet and circulation dynamics (Suboceanic Consultants, Inc., 1978), (Jones 1980); environmental quality (SWFRPC, 1975); and long term trends in water chemistry (DER, 1980 in Estevez, 1984). These studies provide "window" views of the bay separately and when considered together open the door to an acquaintance with the Bay. Long term comprehensive studies of Bay water quality parameters coupled with effective land use planning, watershed protection and strict control of dredge and fill activities will be necessary to protect the quality of the estuary. The Estero Bay Watershed and the barrier islands adjacent to the Bay continue to develop at a rapid pace. A major decision will have to be made soon by Lee County and the DNR on what the Bay's fate is to be. This decision has been delayed while projects are proposed including ones to dredge the entire channel which parallels Estero Island and to build a nearly 2 mile bridge extending from the mainland to Black Island. The former project, proposed by private citizens, has recently received lack of funding support from the U.S. Army Corps of Engineers. The latter project has been proposed by the Lee County Board of County Commissioners who have appropriated \$955,000 for Fiscal Year 1986-87 for studies on the proposed project. These types of major projects, if carried out, will make the decision on the Bay's fate harder, if not impossible to make. Meanwhile smaller projects are proposed and carried out. These include maintenance dredging, dock construction and shoreline development. Unless a decision on the Bay's fate is made soon, it will no longer be an important one to make.

The Department of Natural Resources (1983) designates Estero Bay on page 3 of the Estero Bay Aquatic Preserve Management Plan as a wilderness preserve. Is Estero Bay to be protected as a wilderness preserve, a recreational boating area, a commercial fishing resource or as an aesthetic resource for Lee County? While these classifications or uses are not necessarily mutually exclusive, it may not be possible to accomodate all of them in the future. It may be more feasible to maximum the value of the Bay by managing and protecting it for some, but not all of these uses.

Estero Bay is a dynamic ecosystem. Dynamic and carefully considered action will be necessary to protect its intrinsic values.

Purpose and Scope

The purpose of this report is to present data which will allow a better assessment to be made of the current health of Estero Bay. The main focus of this study was the analysis of bottom sediments for selected parameters including trace metals, pesticides and nutrients. This focus heretofore has not been undertaken for Estero Bay. Thus, the bottom sediment data serves to establish baseline concentrations. Future land use and permitting considerations can be influenced by not only this baseline data but subsequent data as well.

The water column and circulation pattern data also contained in this report complement the sediment data and provide a wider scope for this report. The Lee County Environmental Laboratory has been collecting data in Estero Bay since January, 1978. This sampling has been conducted primarily in south Estero Bay near Big Hickory Pass. This pass has been closed, except for brief openings following dredgings and a storm in June, 1982, since September 1976 (Suboceanic Consultants, Inc., 1978).

The Lee County Environmental Laboratory plans to expand the scope of the south Estero Bay monitoring program both in area covered and parameters sampled to allow continual comparisons to be made to at least some of the data contained in this study.

Description of the Study Area

Estero Bay (Figures 1 and 2) is a shallow, turbid, approximately 11,300 acre sub-tropical estuary located in Lee County, Florida (Map 1). Fringing mangroves form its shoreline which is bordered to the west by a chain of barrier islands which separate it from the Gulf of Mexico. These islands include Estero Island (Fort Myers Beach), Lovers Key and Big Hickory Island and Little Hickory Island (Bonita Beach). The major passes are New Pass, Big Carlos Pass and Matanzas Pass.

The Bay consists of sea grass meadows, extensive oyster bars, sandy bottoms and mangrove islands (Tabb et al, 1971). It has four main tributaries - Hendry - Mullock Creek, the Estero River, Spring Creek and the Imperial River.

The entire Bay, with the exception of the area west of the channel paralleling Estero Island, is an aquatic preserve managed by the Department of Natural Resources.

Acknowledgements

We wish to thank Bob Repenning and Kevin Bowen, Department of Natural Resources, Estero Bay Aquatic Preserve, for assistance provided in collecting data for this study.

PRESENTATION OF DATA

Data is presented both in tables, and for selected parameters, in figures. The three areas for which data were included water column analysis, bottom sediment analysis and circulation patterns.

Figures 3 through 27 depict on a map of Estero Bay the approximate locations of sampling sites. The individual or average value for the parameter sampled has been placed next to the station location. This approach allows ease of future data comparison and makes the data visually conducive to use during review of permits and development applications. The data presented in the figures complements and relates directly to data contained in the tables.



Map 1

Location Map of Lee County Florida

Water Column Analysis

The water column was sampled in the dry season (January) and the wet season (August). Parameters included physical-chemical, nutrients and fecal coliform and fecal streptococcus. Sample sites were selected by using aerial photographs, navigational charts and visual observation by boat. Sample collection methods are discussed in the Appendix.

Figures 3, 4 and 10 and Tables 2 and 6 present data on nutrients collected during the dry and wet seasons. Values for orthophosphorus, total nitrogen and nitrite-nitrate are similar to those presented for Charlotte Harbor in Figures 17, 18 and 20 pps 21, 22 and 24 of the USGS report (Stoker, 1984).

Figures 5-7 and Tables 3, 7 and 11 provides data on physical parameters for the dry and wet seasons. Values for dissolved oxygen had more of a range (3.1 to 10.1 milligrams per liter) than the average values depicted in Figure 10 (page 14) of the Charlotte Harbor Study (Stoker, 1984).

Tables 4 and 8 provide bacteriological data collected in the dry and wet seasons. Estero Bay is presently a closed area for shellfish harvesting. The Department of Natural Resources Shellfish Environmental Assessment Section is currently monitoring the Bay for bacteriological parameters with the goal of reopening the Bay for shellfish harvesting.

Circulation Study

The circulation study of the Bay was performed in two phases during the wet season. Flow meters were not used in the tributaries during the study. The USGS does not have stage discharge gauges for the Estero Bay tributaries but is planning to install gauges in Fall 1986 in Ten Mile Canal (which drains into Mullock Creek) and the Imperial River. The studies were performed in phases because of the assumption that Hendry-Mullock Creeks might influence circulation in some of the same areas as the Estero River and that Spring Creek might influence circulation in some of the same areas as the Imperial River. Thus, the first phase involved Hendry-Mullock Creeks and Spring Creek and the second phase involved the Estero and Imperial Rivers.

Figure 8 depicts station numbers and their location and approximate circulation patterns for about 7 hours after placement of the dye in the mouth of the tributaries. Sampling performed the day after dye placement and after nearly 2 complete tidal cycles showed the dye still to be present in the bay but not in measurable amounts (<0.3 mg/l) at the major passes (Big Carlos and New Pass). This indicates that water from the tributaries has a residency time in the bay of at least several days during the wet season.

The results also corroborate the statement made by Tabb (1971) "that the Estero Bay system may be hydrologically divisible into two major regions by a northeast-southwest oriented line drawn through the lower portion of Julies Island."

The results of the second phase of the circulation study is represented by Figure 9 which depicts station members and their locations and the approximate circulation patterns for approximately 24 hours after dye placement. Data for Estero River are inconclusive and Figure 9 represents visual observation of dye travel for several hours after it was placed in the river, but the hydrography in the Imperial River mouth area seems to influence circulation such that the water from the river has a fairly long residency in Fish Trap Bay and is conveyed via Hogue Channel north. Data do not indicate direction of circulation patterns north of Hogue Channel.

Future circulation studies of Estero Bay should probably combine a combination of dye and drogues to provide better interpretation of circulation. It is suggested that the circulation patterns influenced by the passes be compared to the influences of the tributaries.

Bottom Sediment Analysis

Sediment samples were collected during the dry and wet seasons. Samples were analyzed for trace metals, nutrients and pesticides. It appears from a study of the literature on Estero Bay that the sediment data provided in this report is the first such data collected for Estero Bay. The U.S. Army Corps of Engineers (1976 in Estevez, 1984) analyzed nutrients, chemical oxygen demand and total organic carbon of sediments for San Carlos Bay.

Comparison of trace metal concentrations from Figures 10-27 and Tables 18, 20, 22 and 24 with Table 8 from the Charlotte Harbor USGS Study (Stoker, 1984) provided the following general conclusions. Ranges for concentrations of aluminum, lead, cadmium and mercury were similar. Chromium, copper and zinc had higher levels in Estero Bay in 1986 than those in Charlotte Harbor had in December 1982.

The concentration levels of pesticides and polychlorinated biphenyls (PCBs) presented in Table 25 were all below minimum detection limits. The variation in minimum detection limits for the data are related to the percent solids, response factors and the methodology used.

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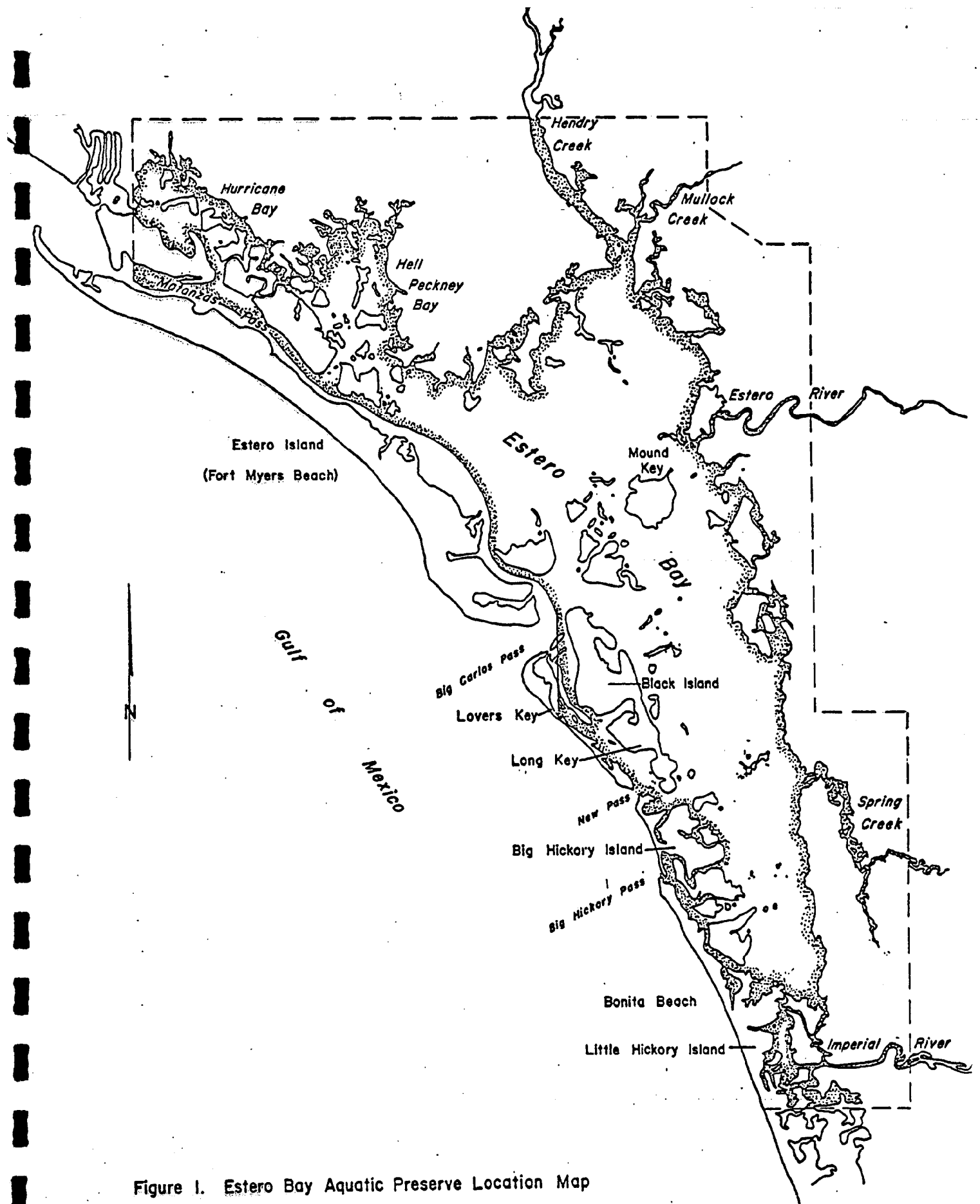
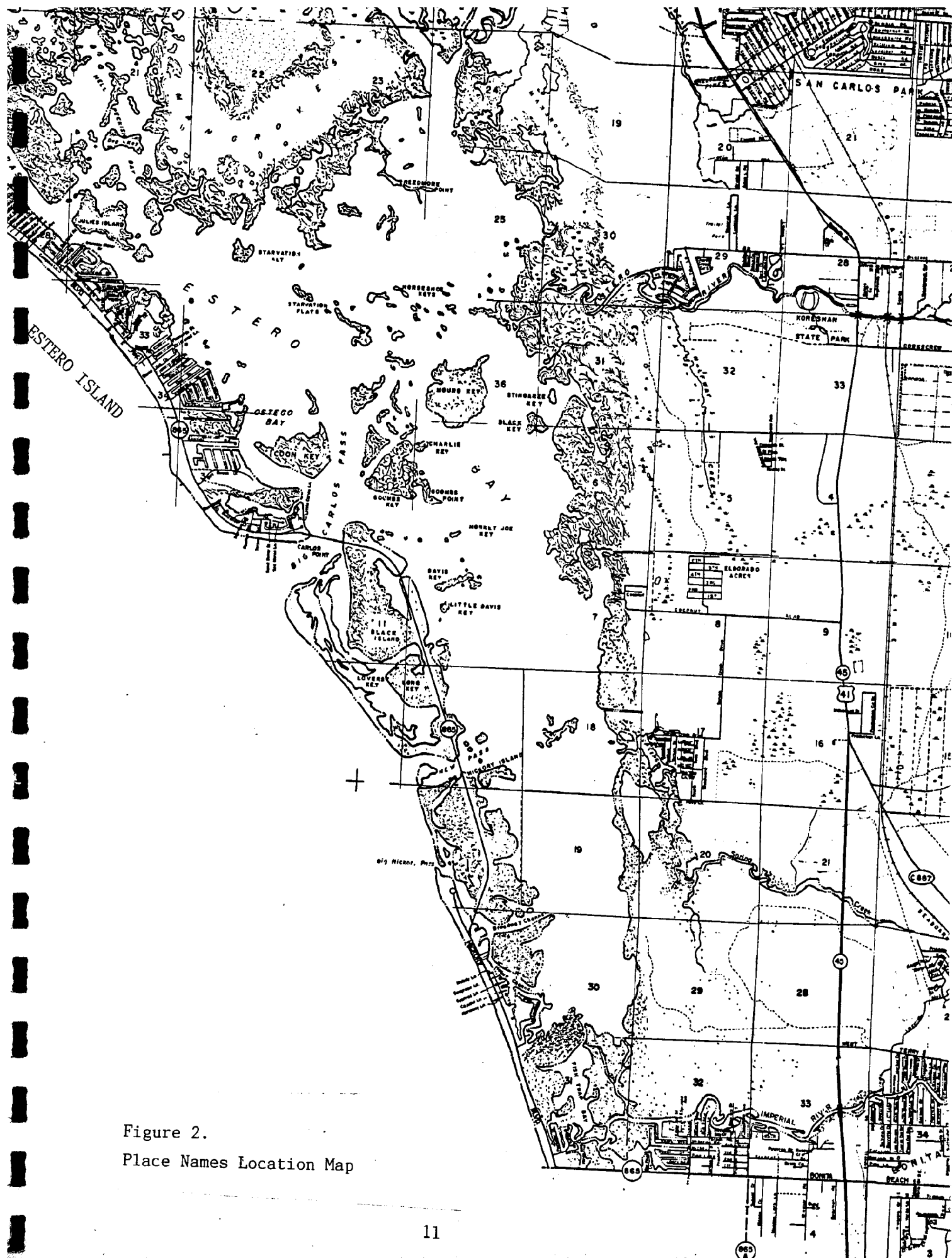


Figure 1. Estero Bay Aquatic Preserve Location Map



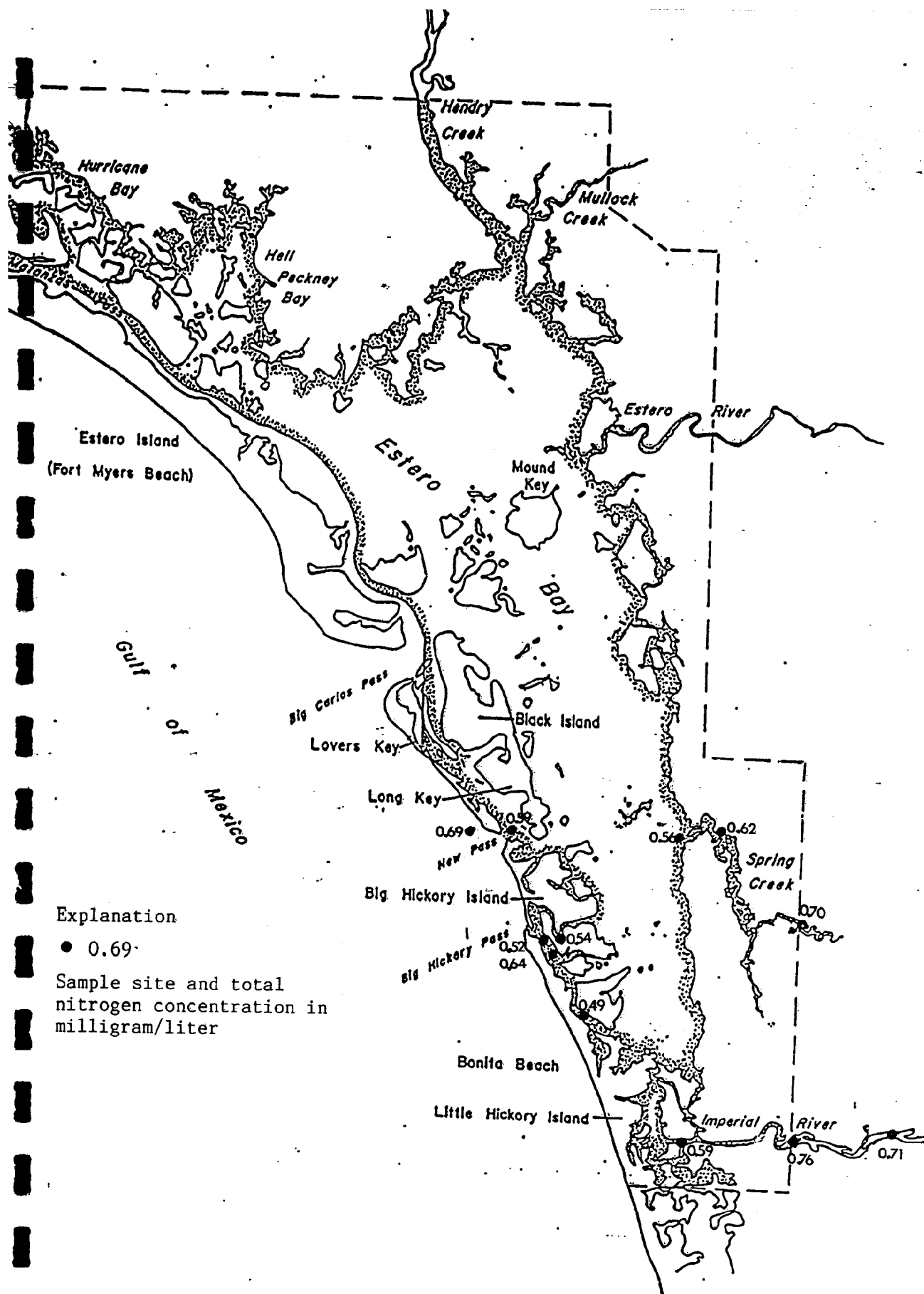
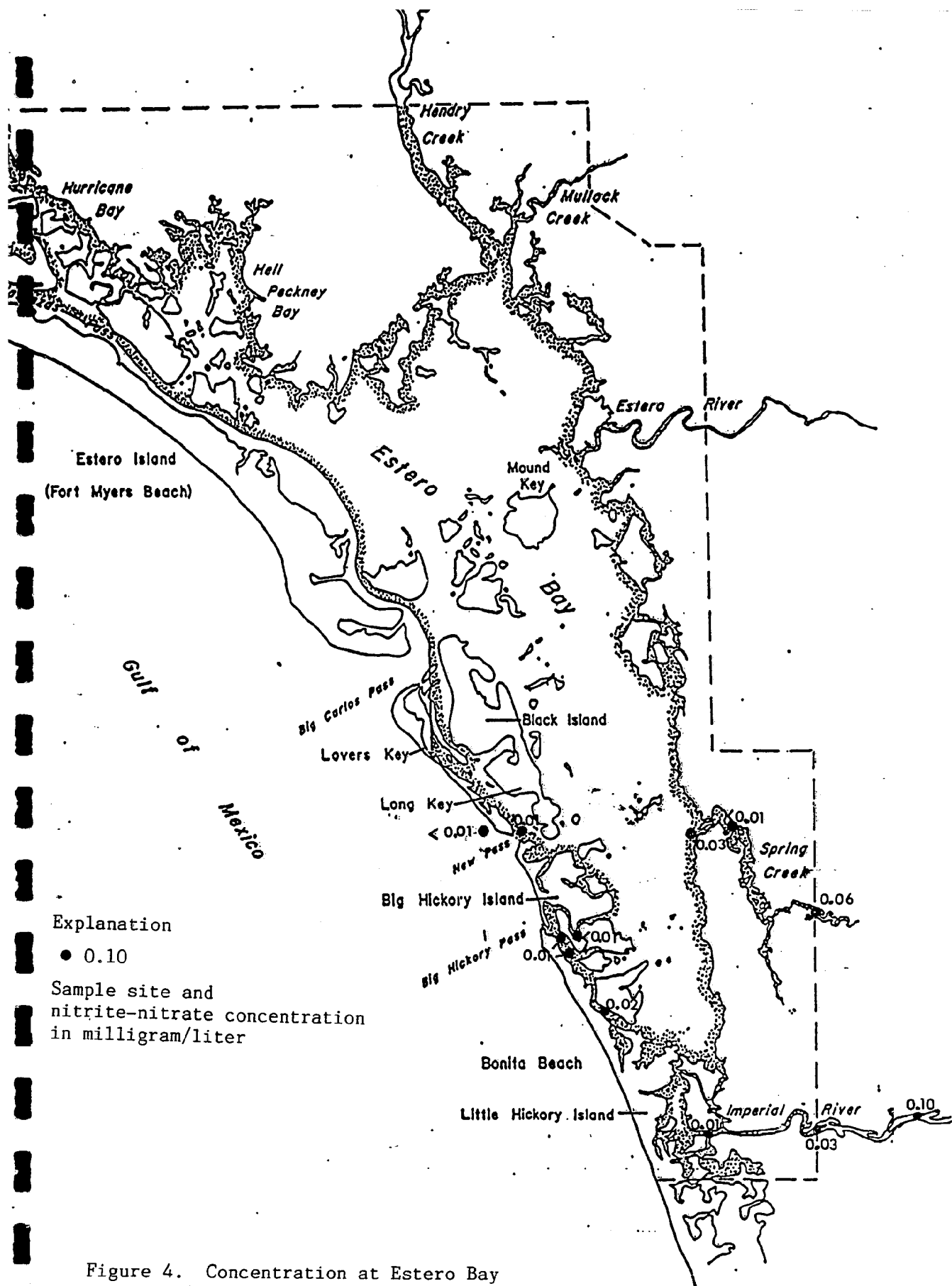


Figure 3. Concentrations at Estero Bay water quality sites, January 16, 1986 of total nitrogen



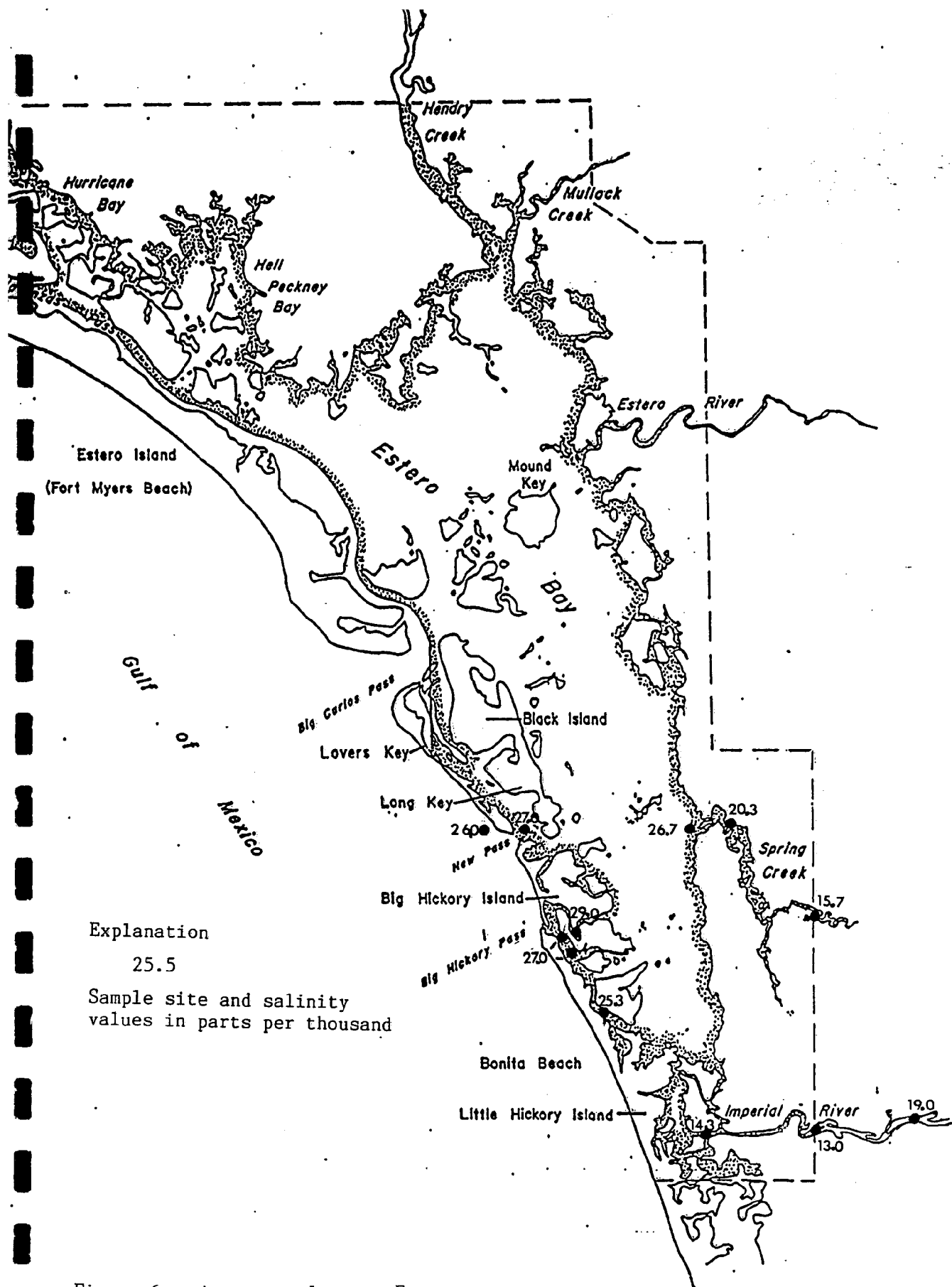


Figure 6. Average values at Estero Bay water quality sites, January 16, 1986 for salinity

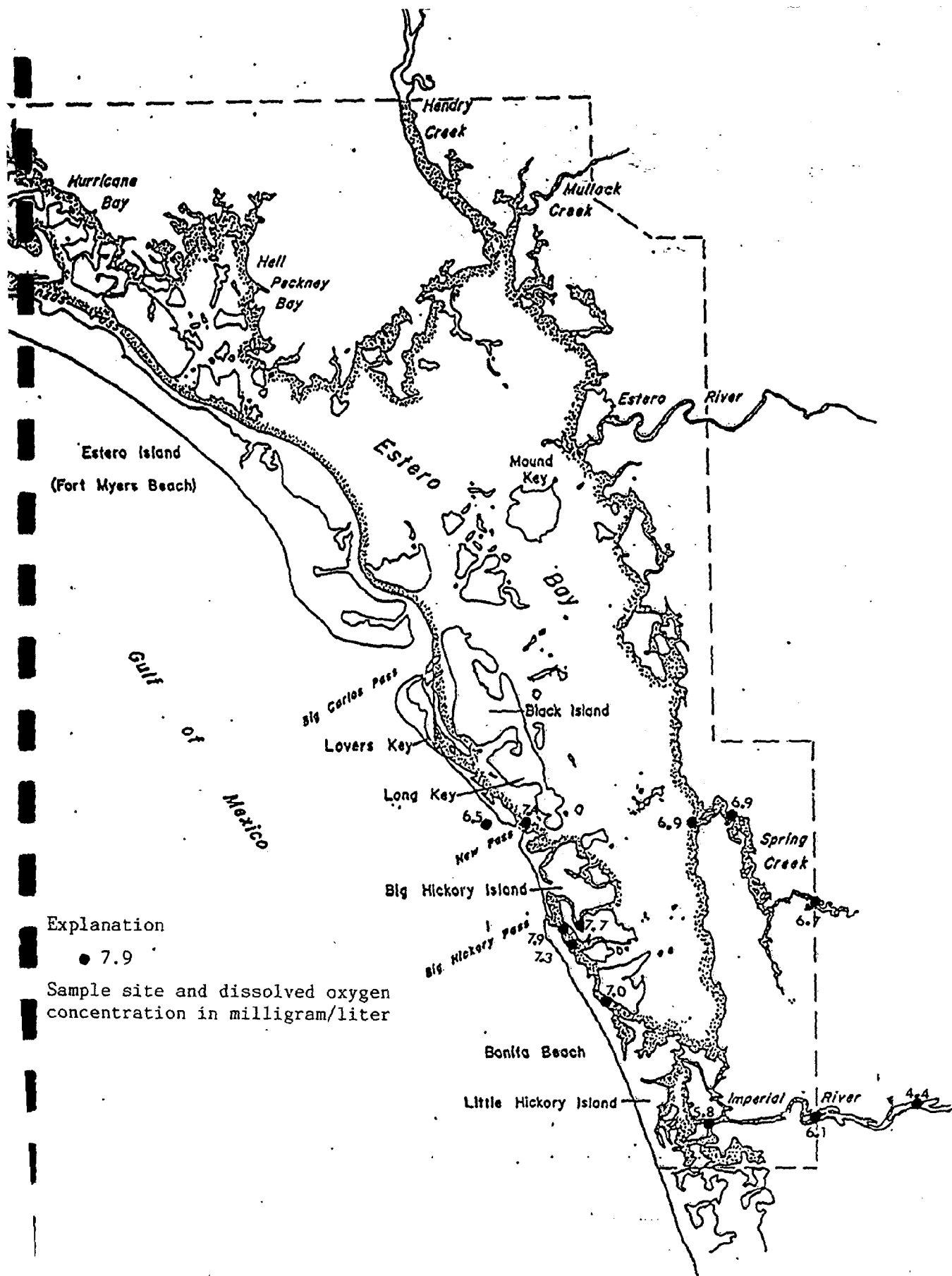


Figure 7. Average concentrations at Estero Bay water quality sites, January 16, 1986, of dissolved oxygen

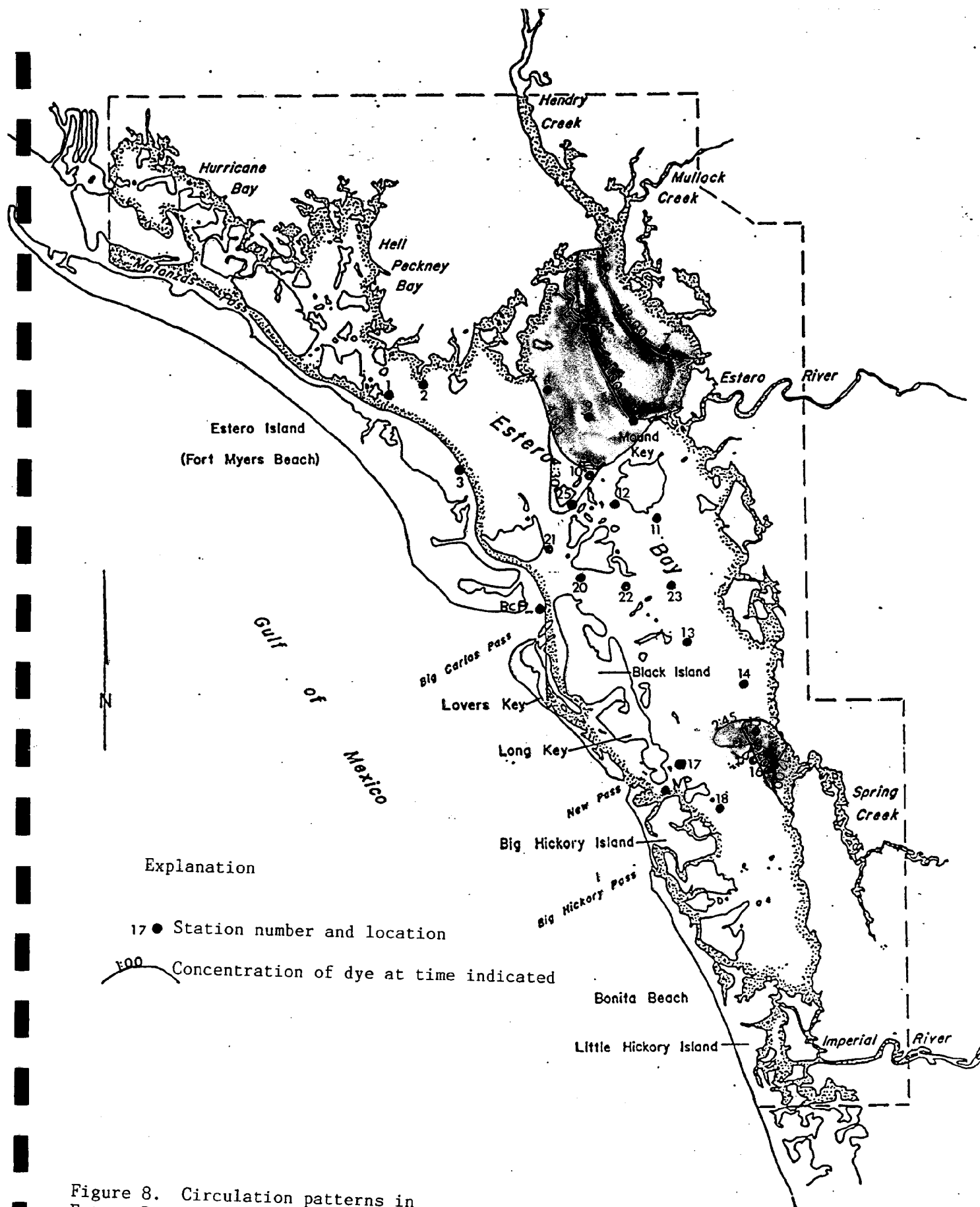


Figure 8. Circulation patterns in Estero Bay as affected by Hendry, Mullock and Spring Creeks
July 17 1986

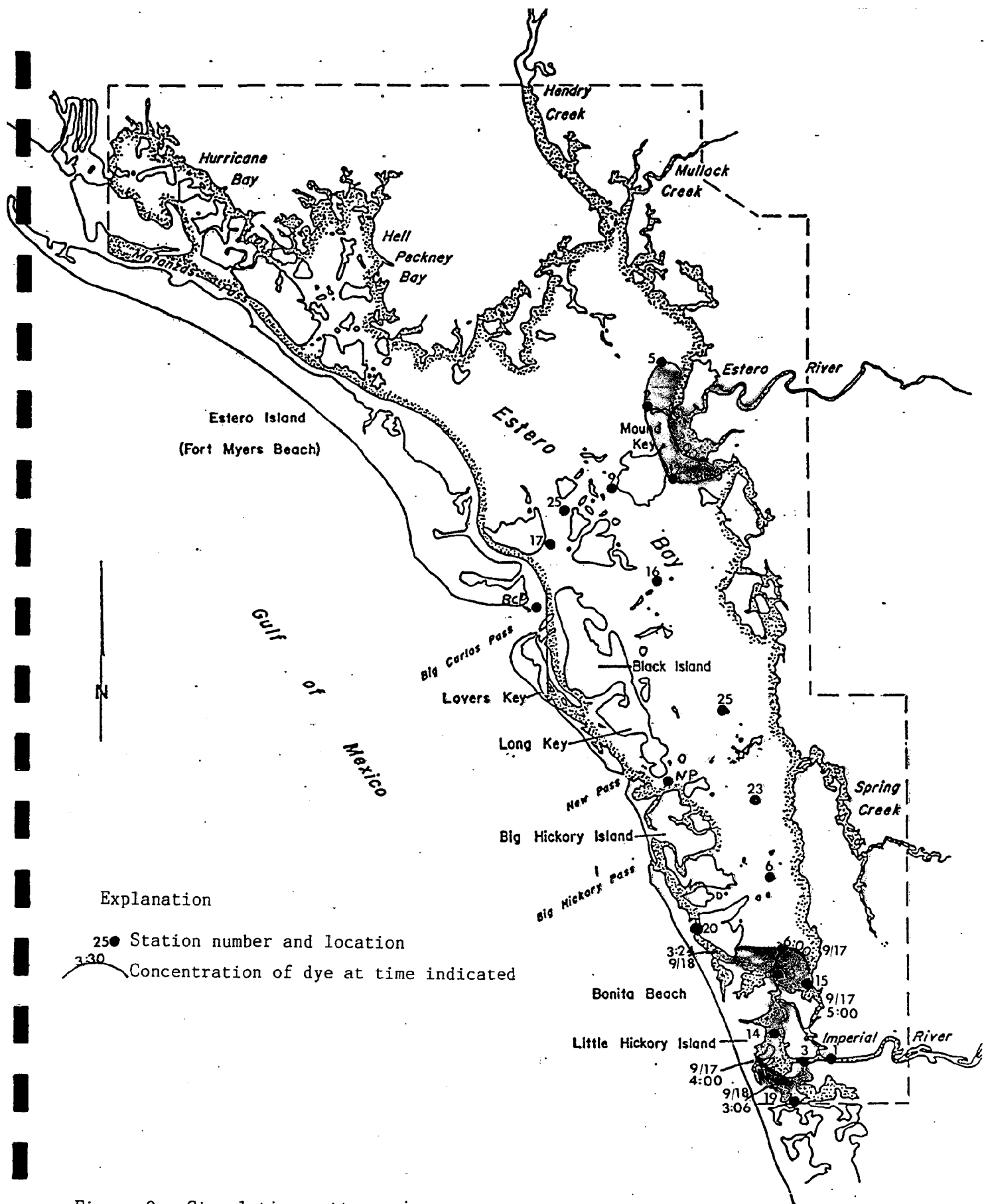


Figure 9. Circulation patterns in Estero Bay as affected by Estero and Imperial Rivers, September 17-18, 1986

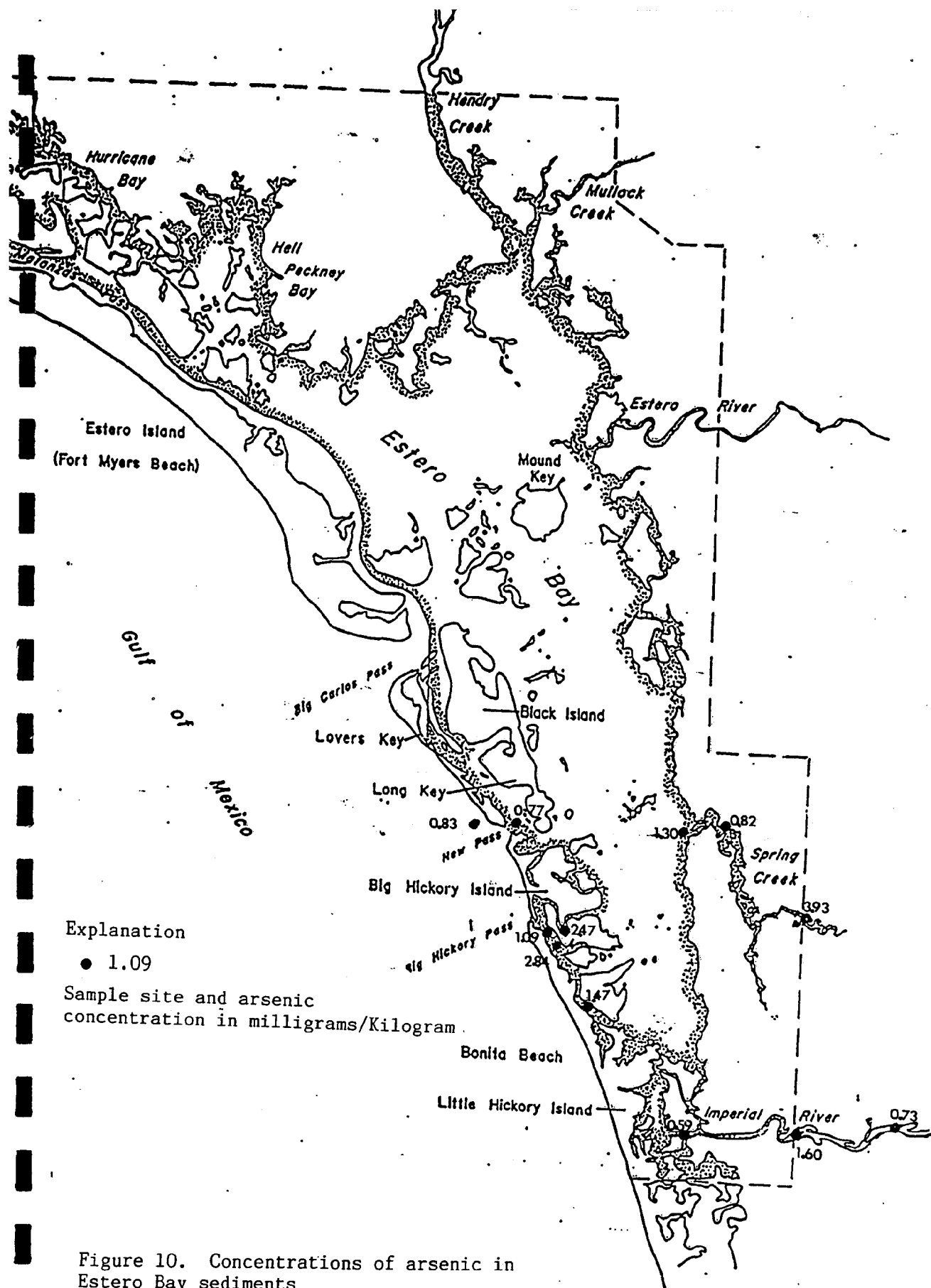


Figure 10. Concentrations of arsenic in Estero Bay sediments
January 15, 1986

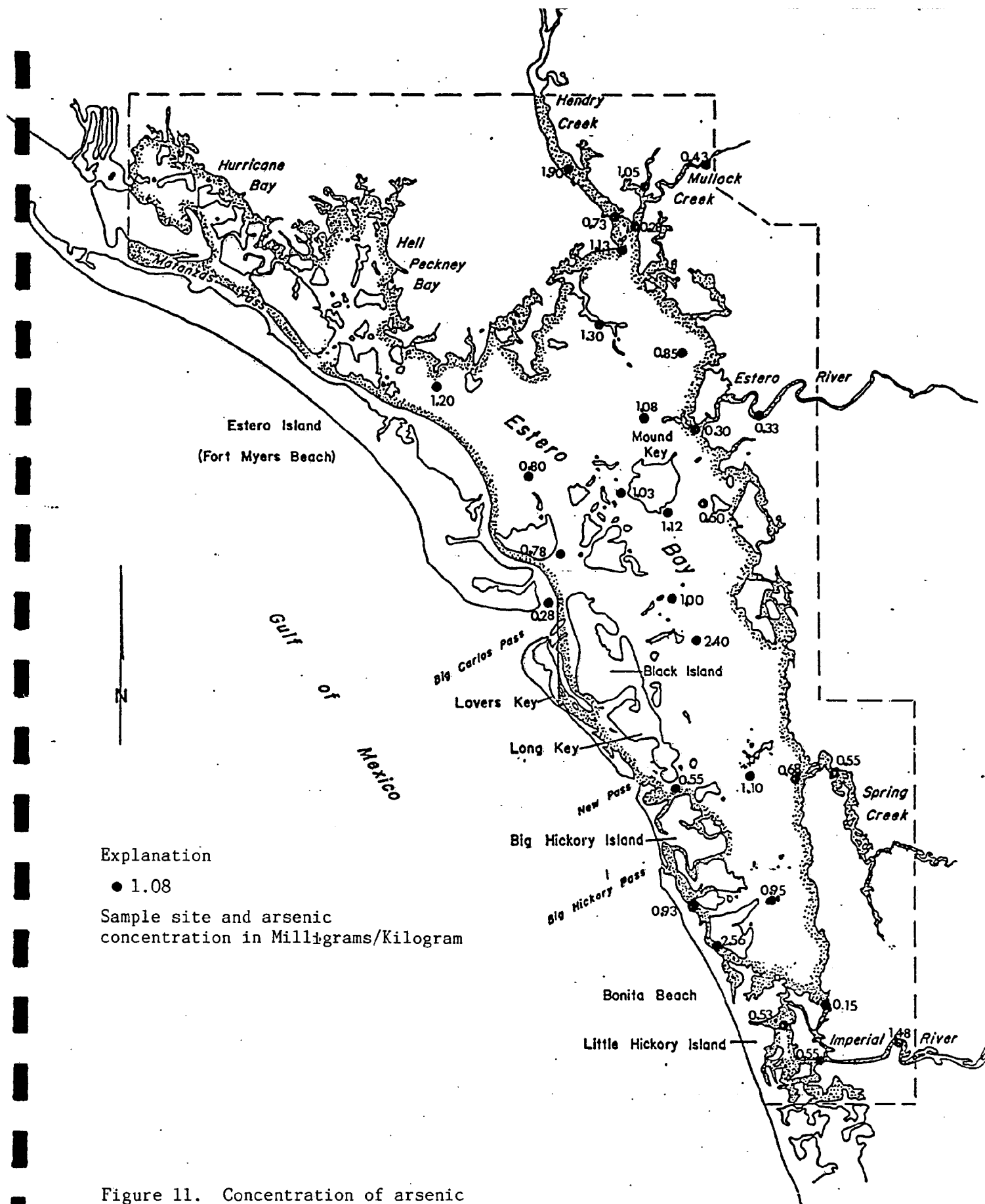


Figure 11. Concentration of arsenic in Estero Bay Sediments August 11, August 27 and September 3, 1986

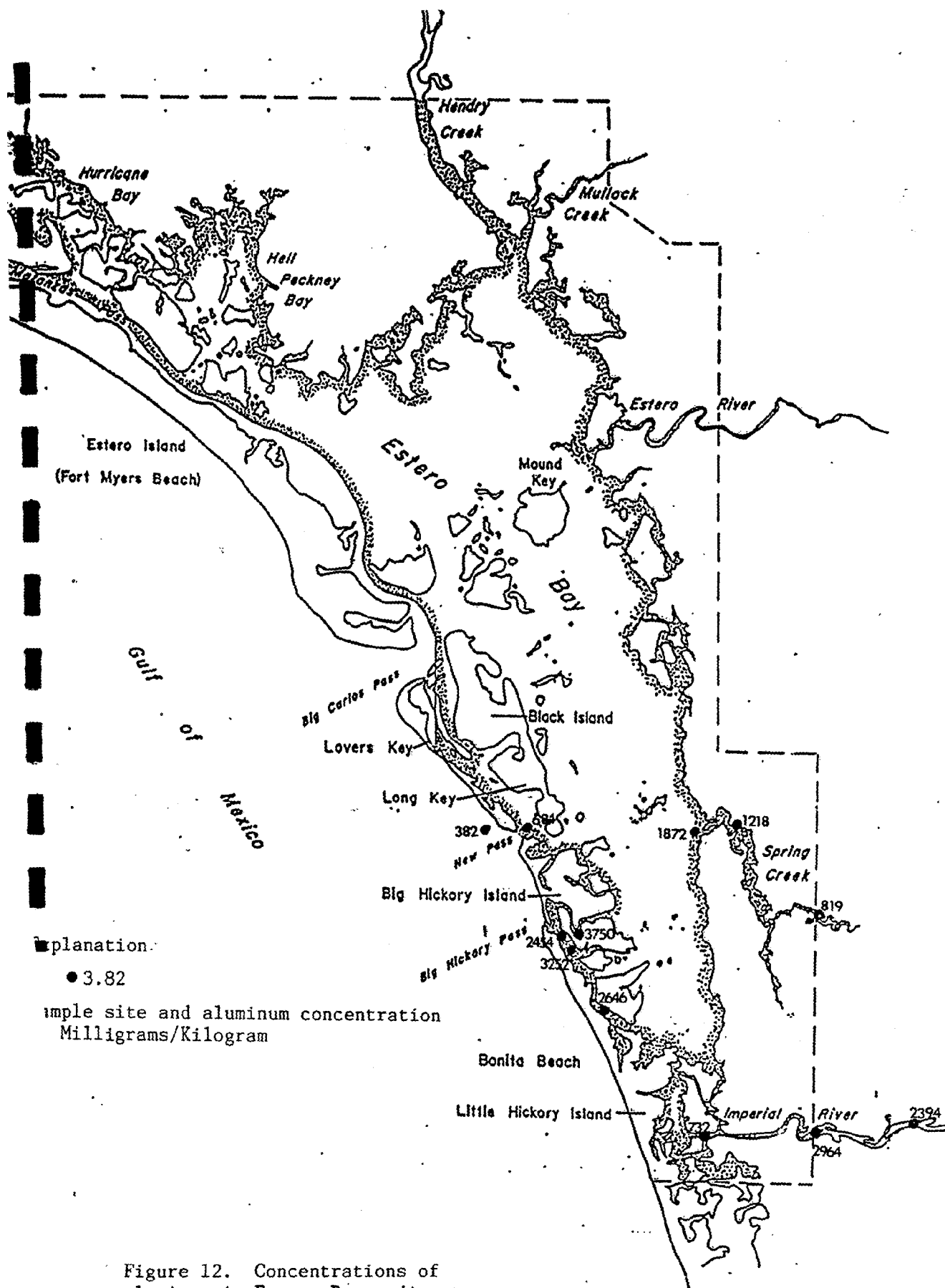
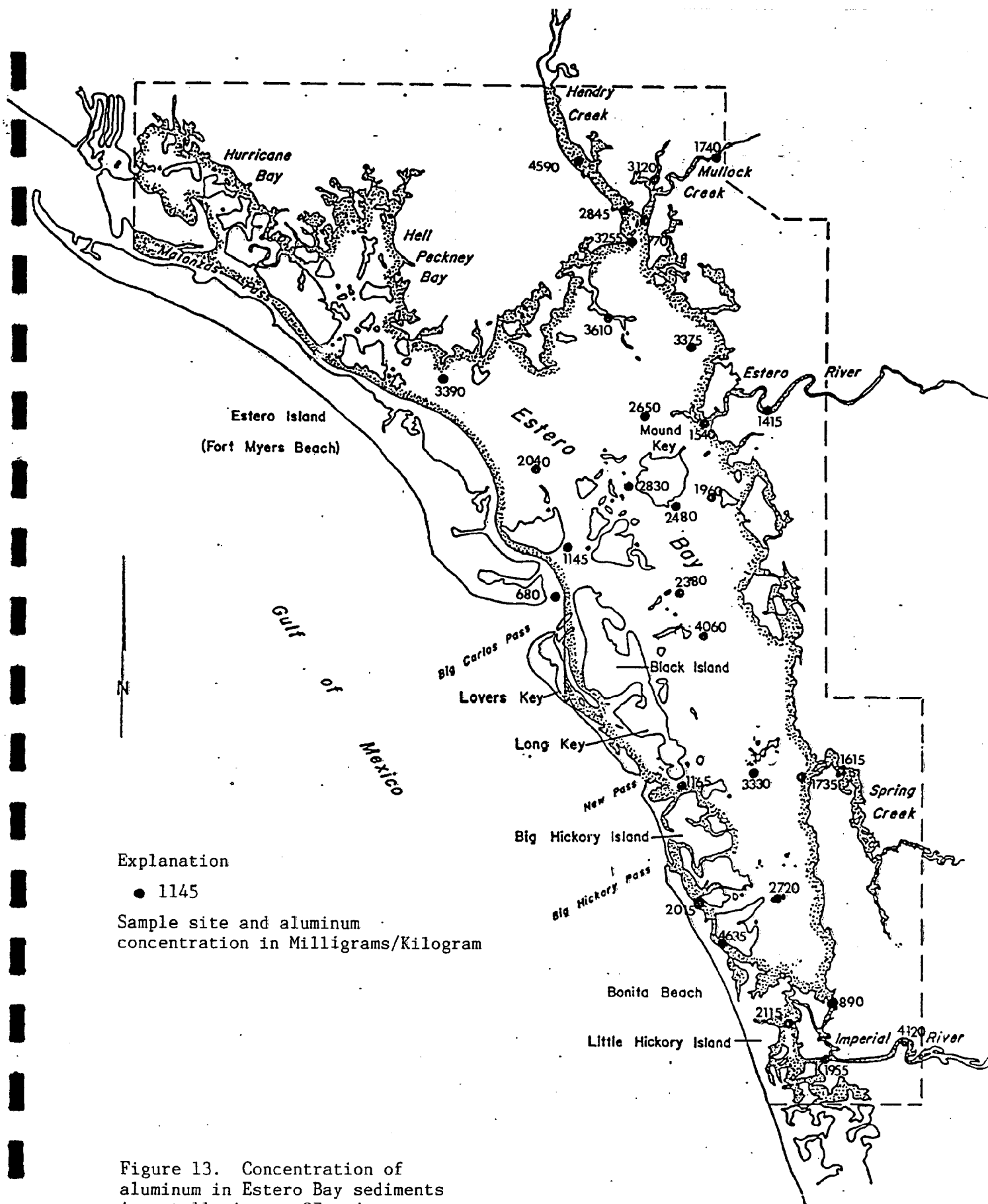


Figure 12. Concentrations of aluminum in Estero Bay sediments January 15, 1986



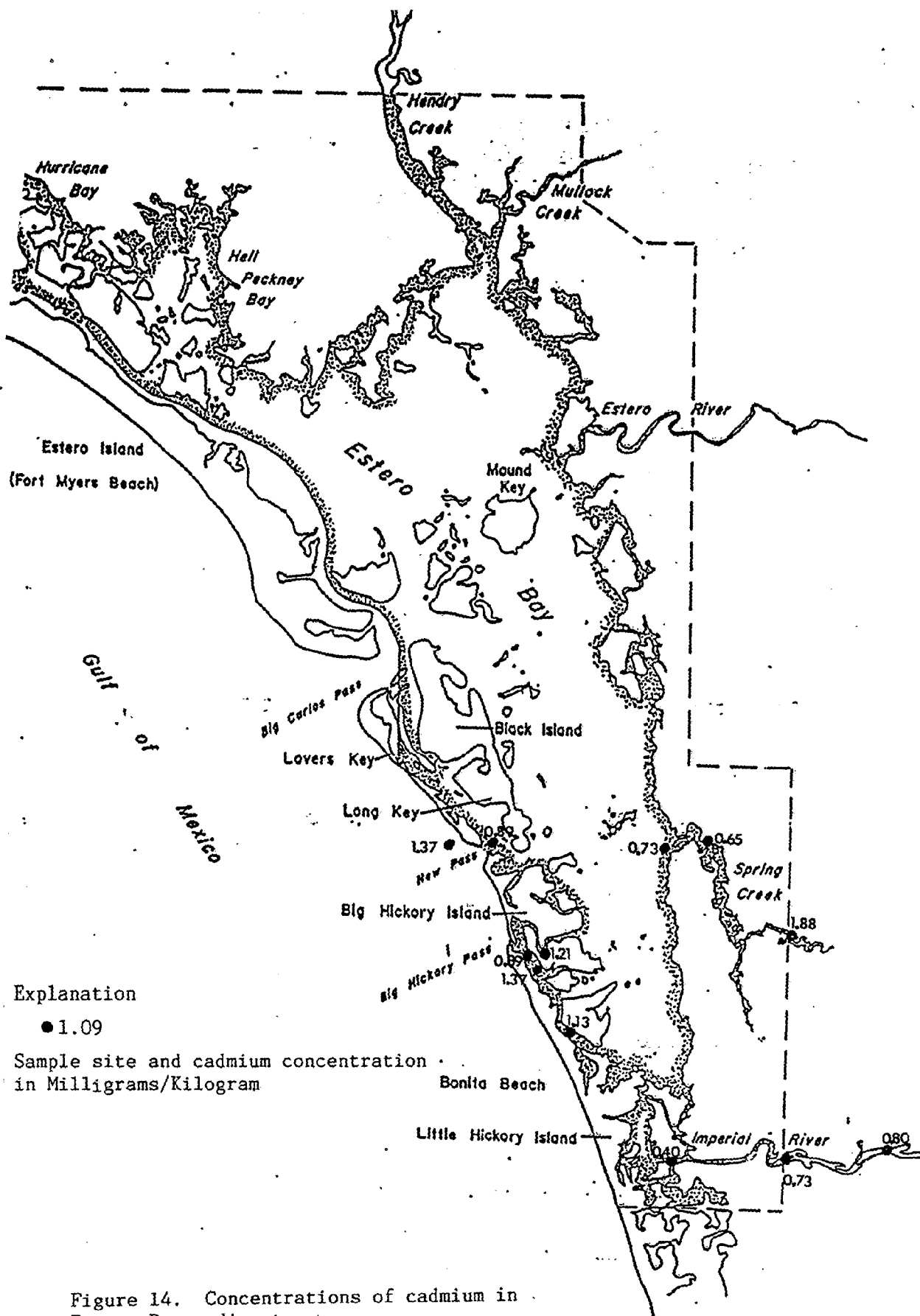
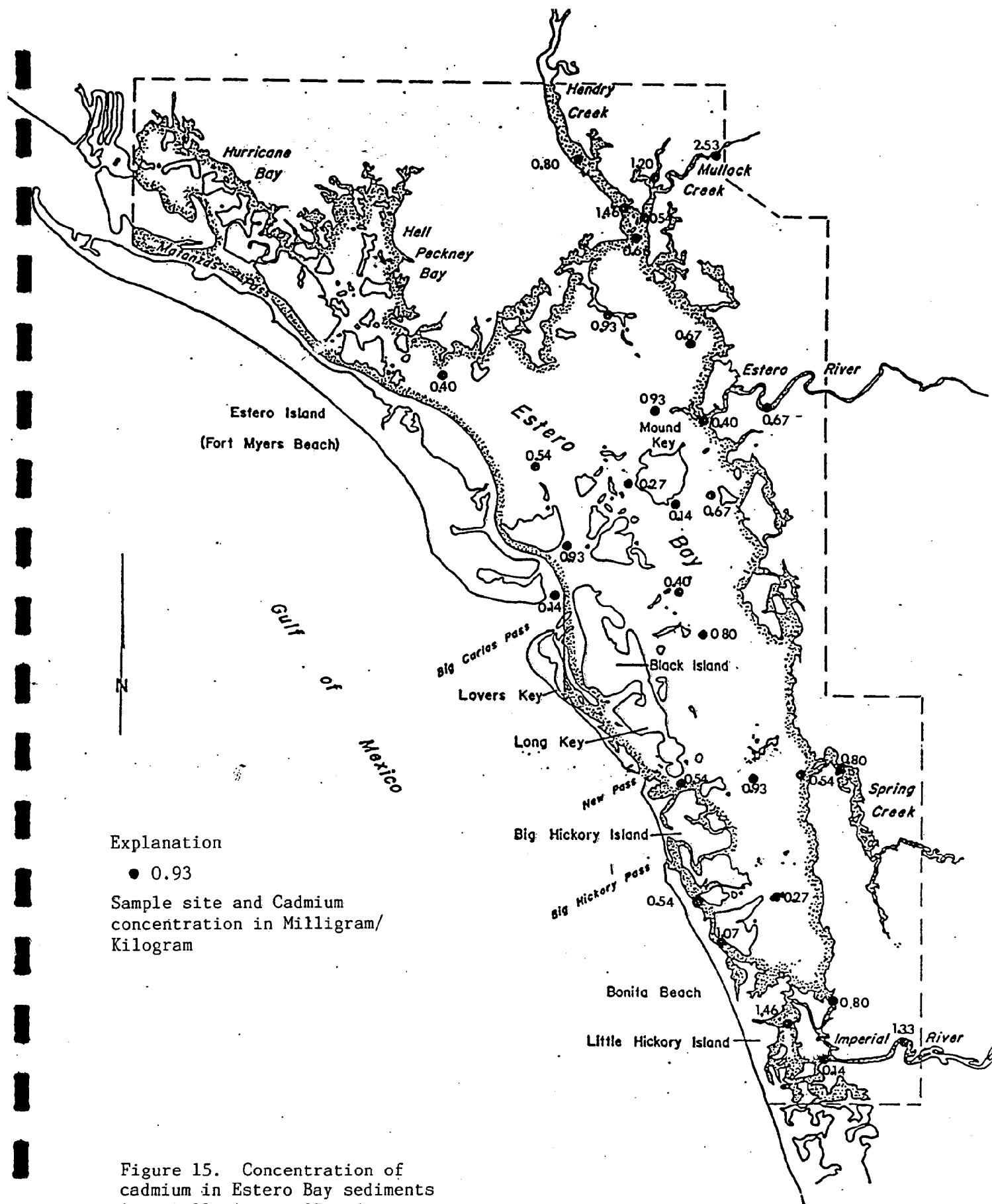


Figure 14. Concentrations of cadmium in Estero Bay sediments January 15, 1986



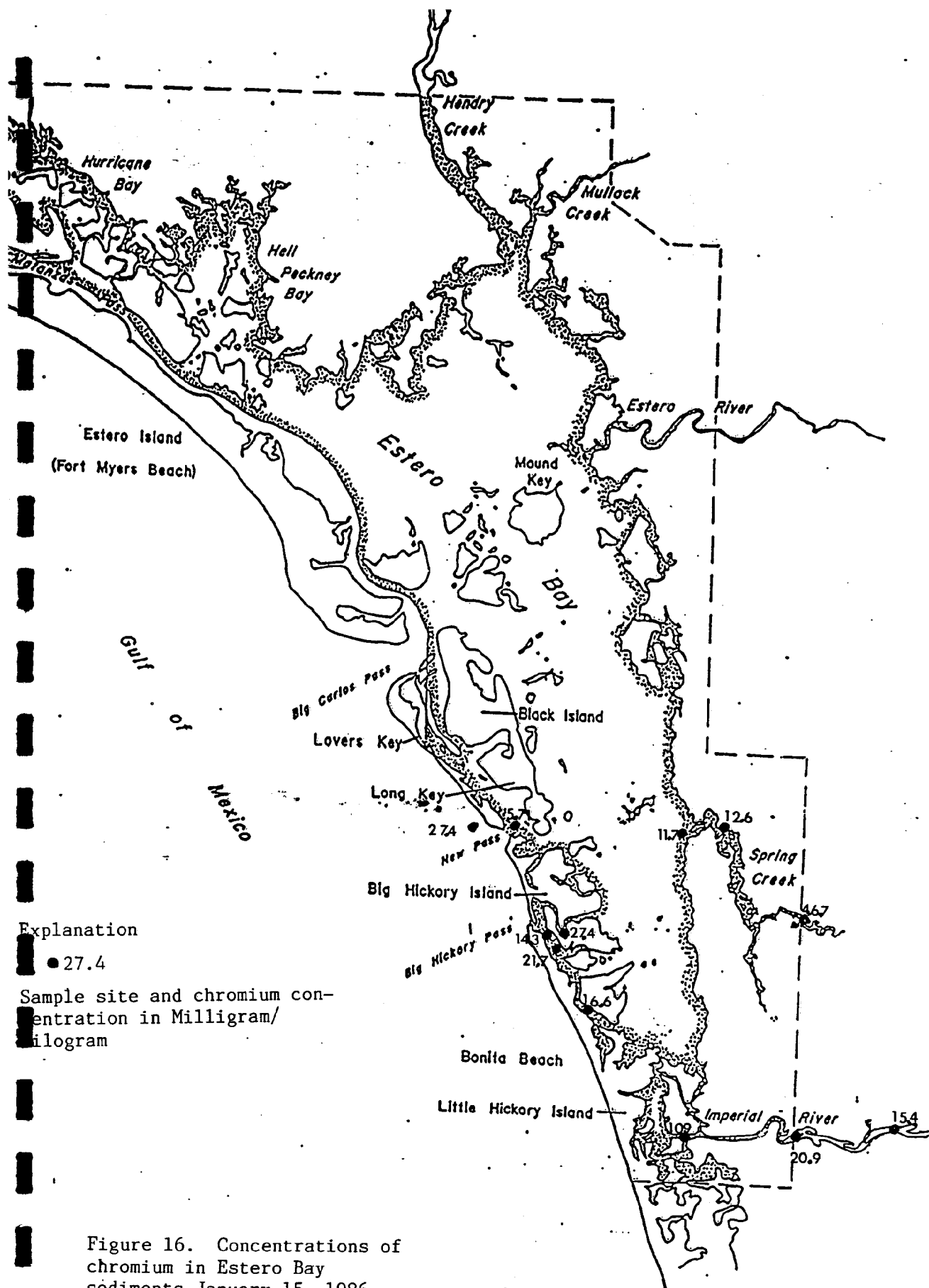
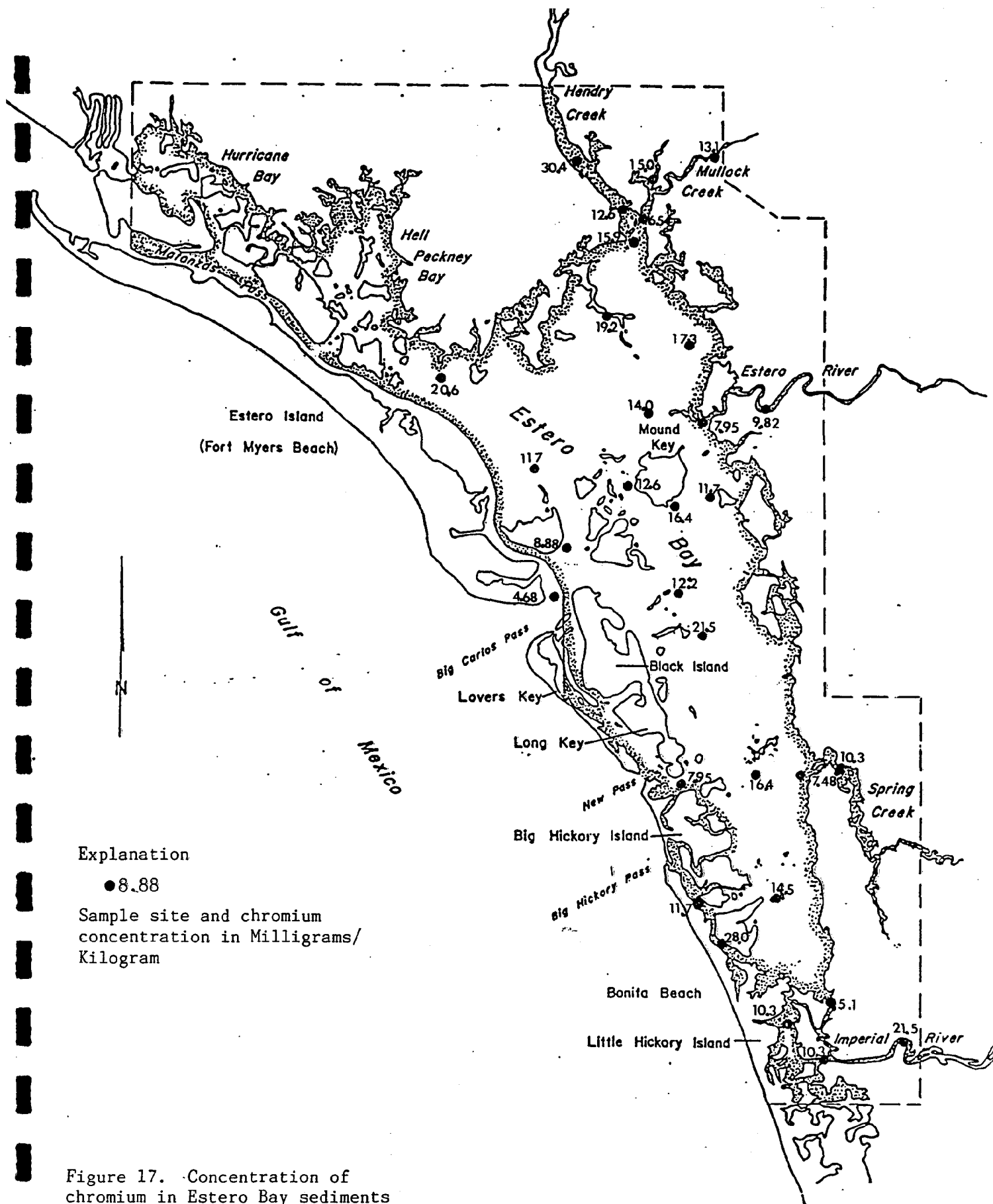
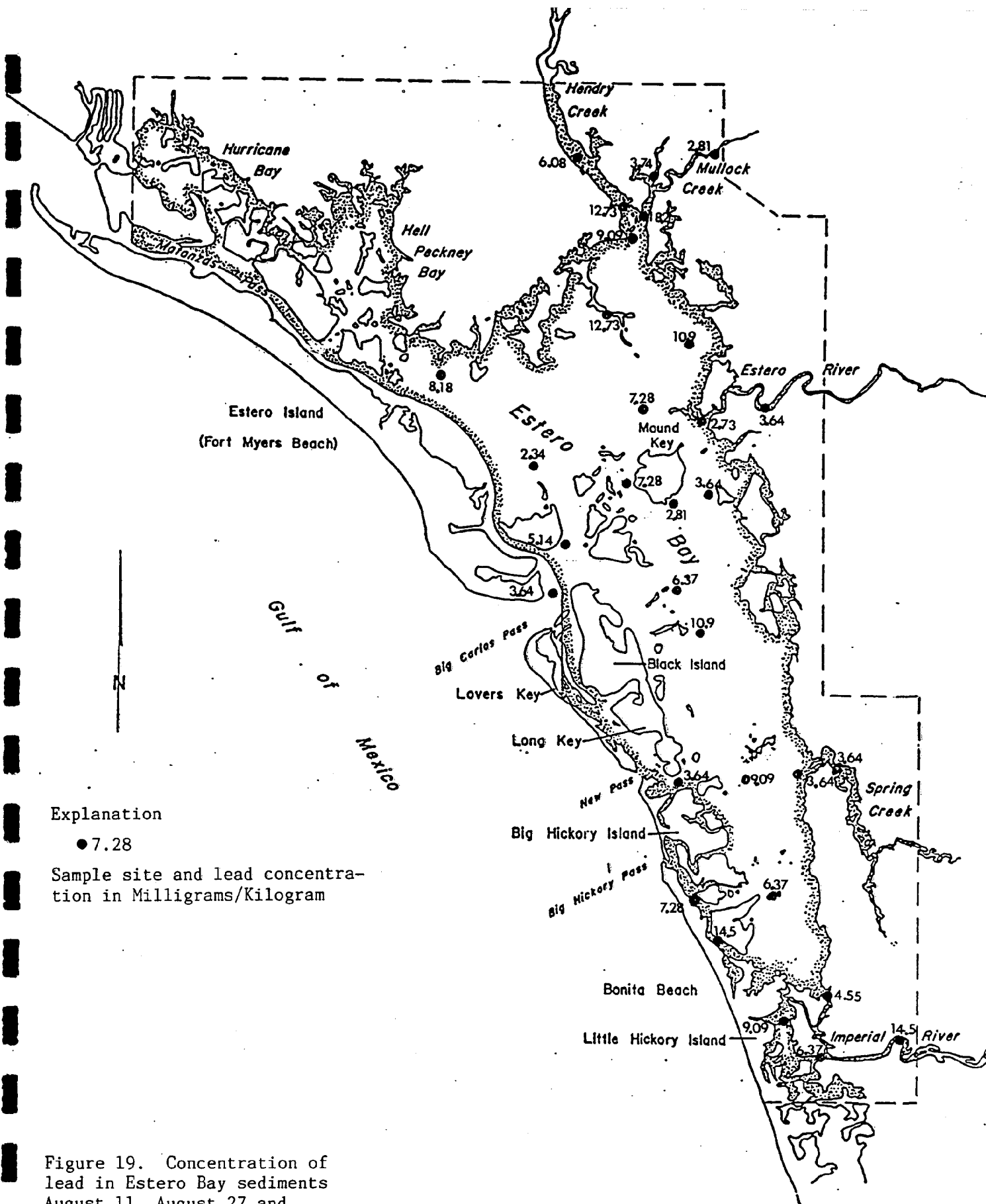
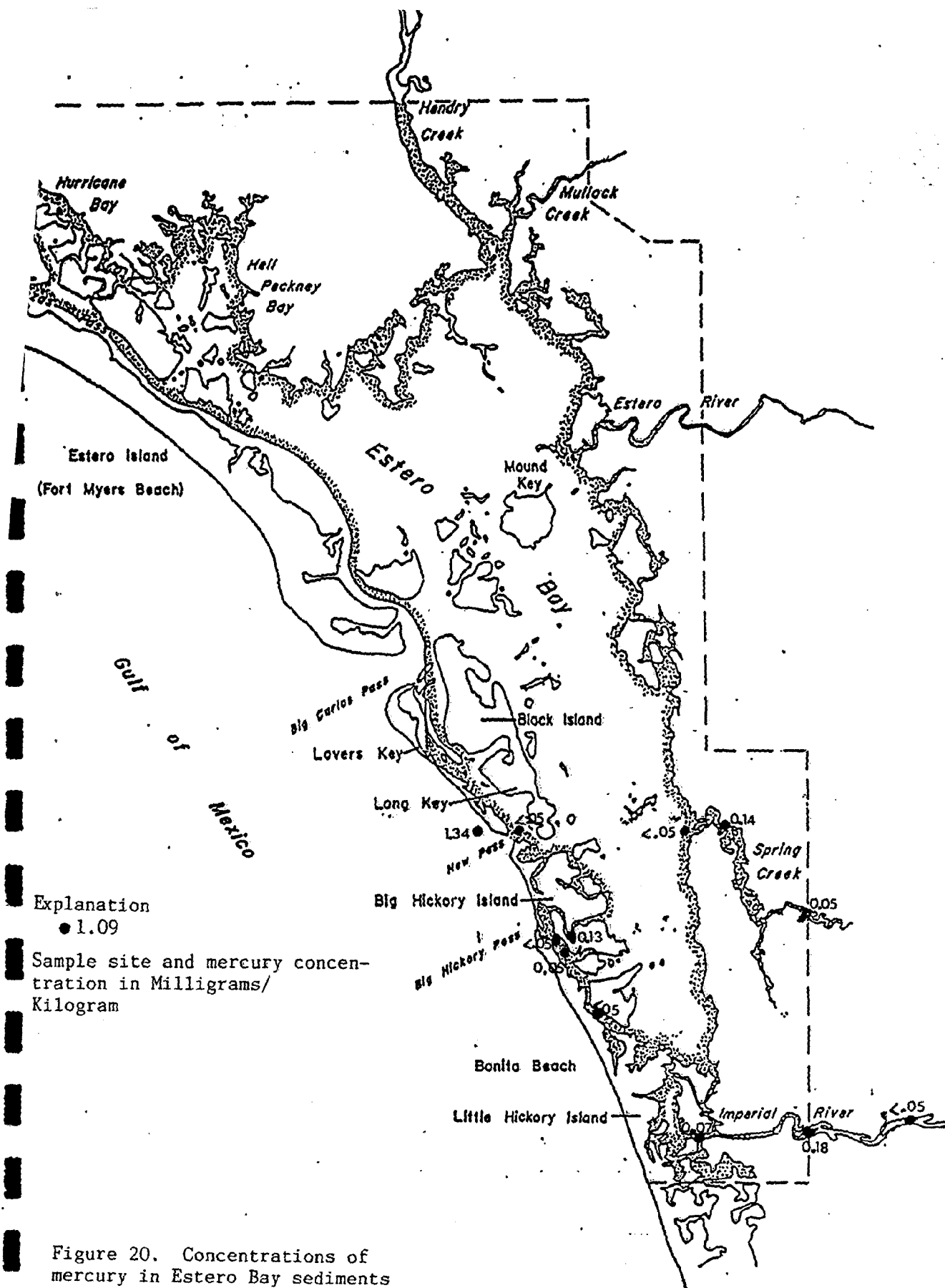
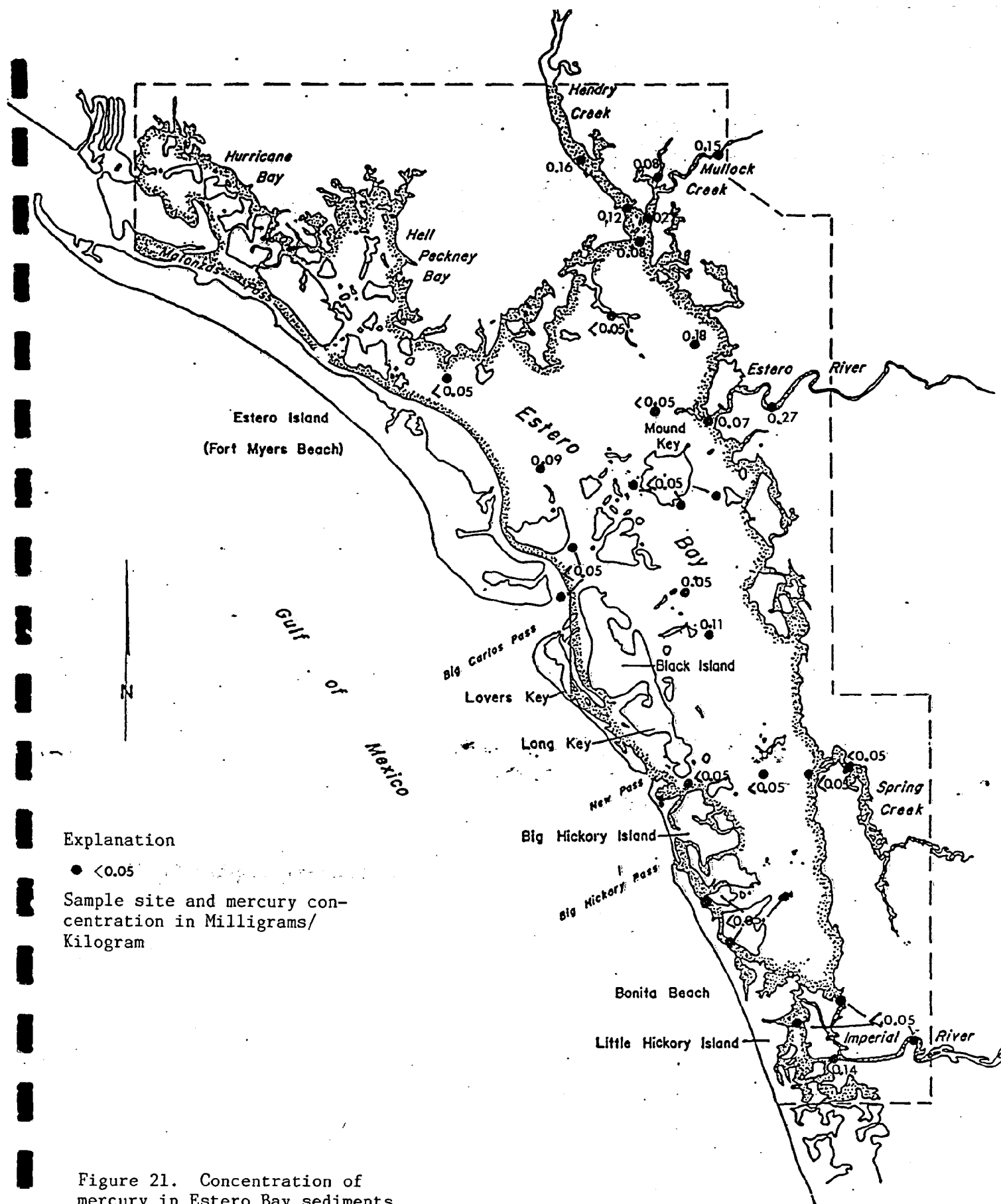


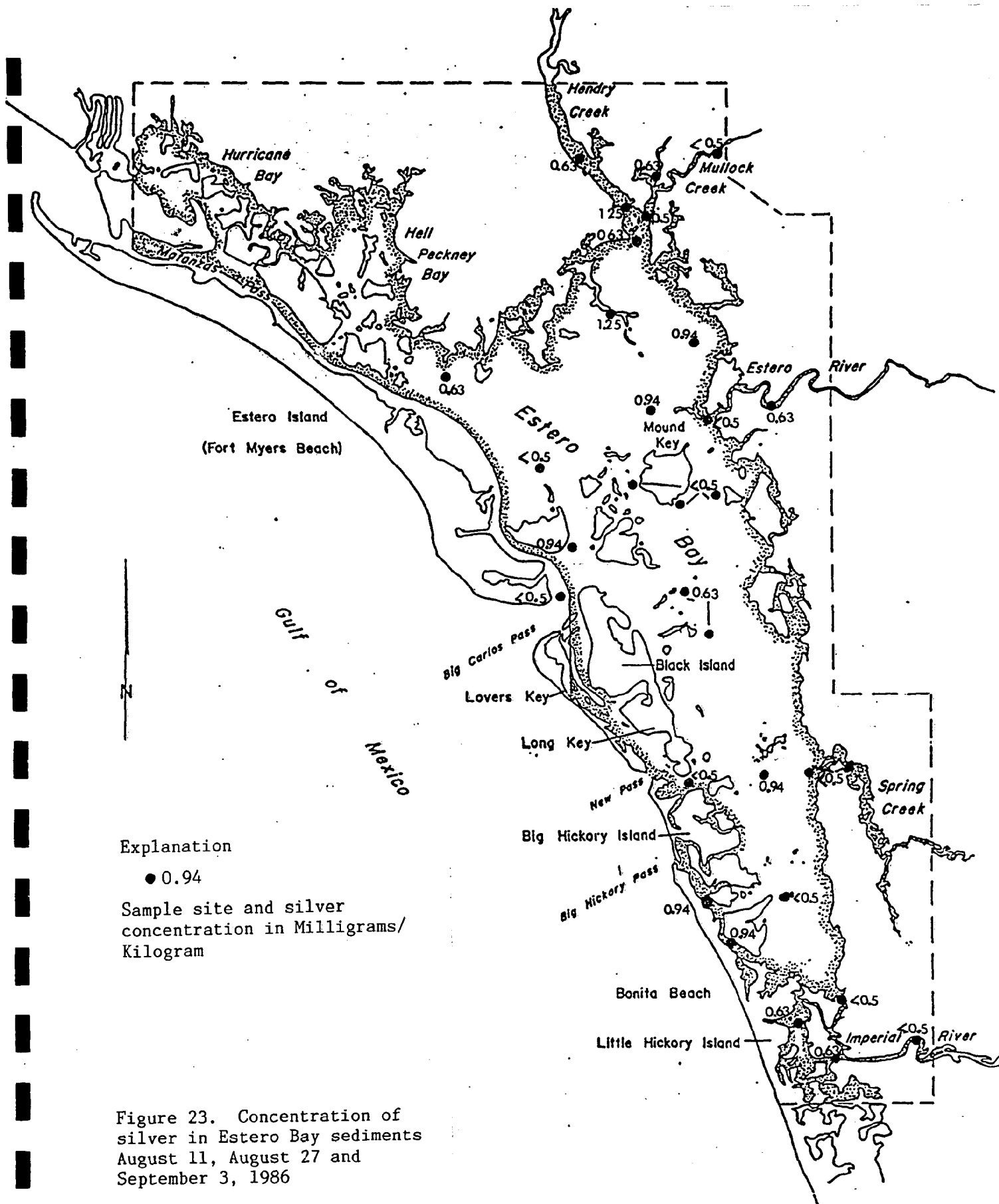
Figure 16. Concentrations of chromium in Estero Bay sediments January 15, 1986

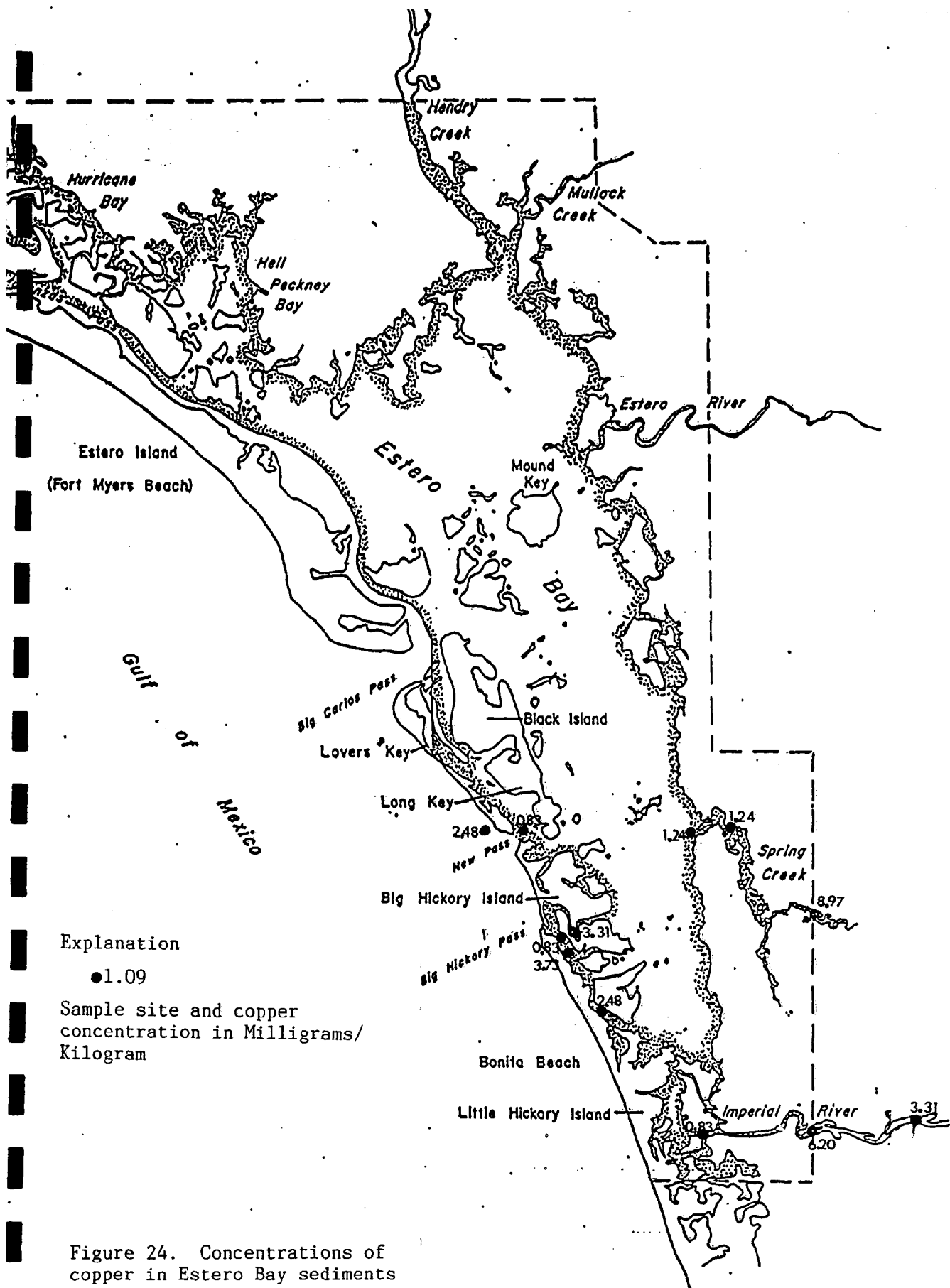


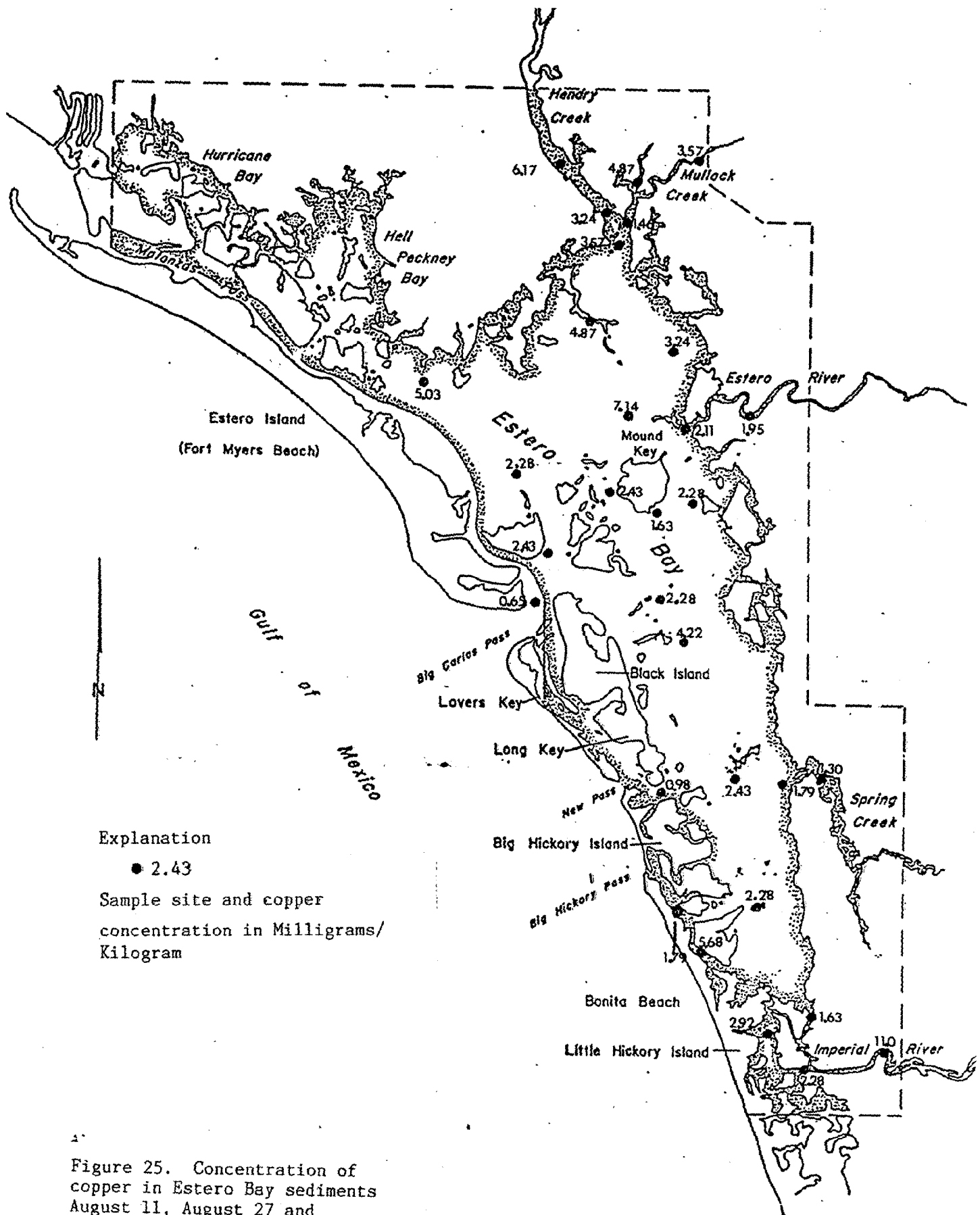


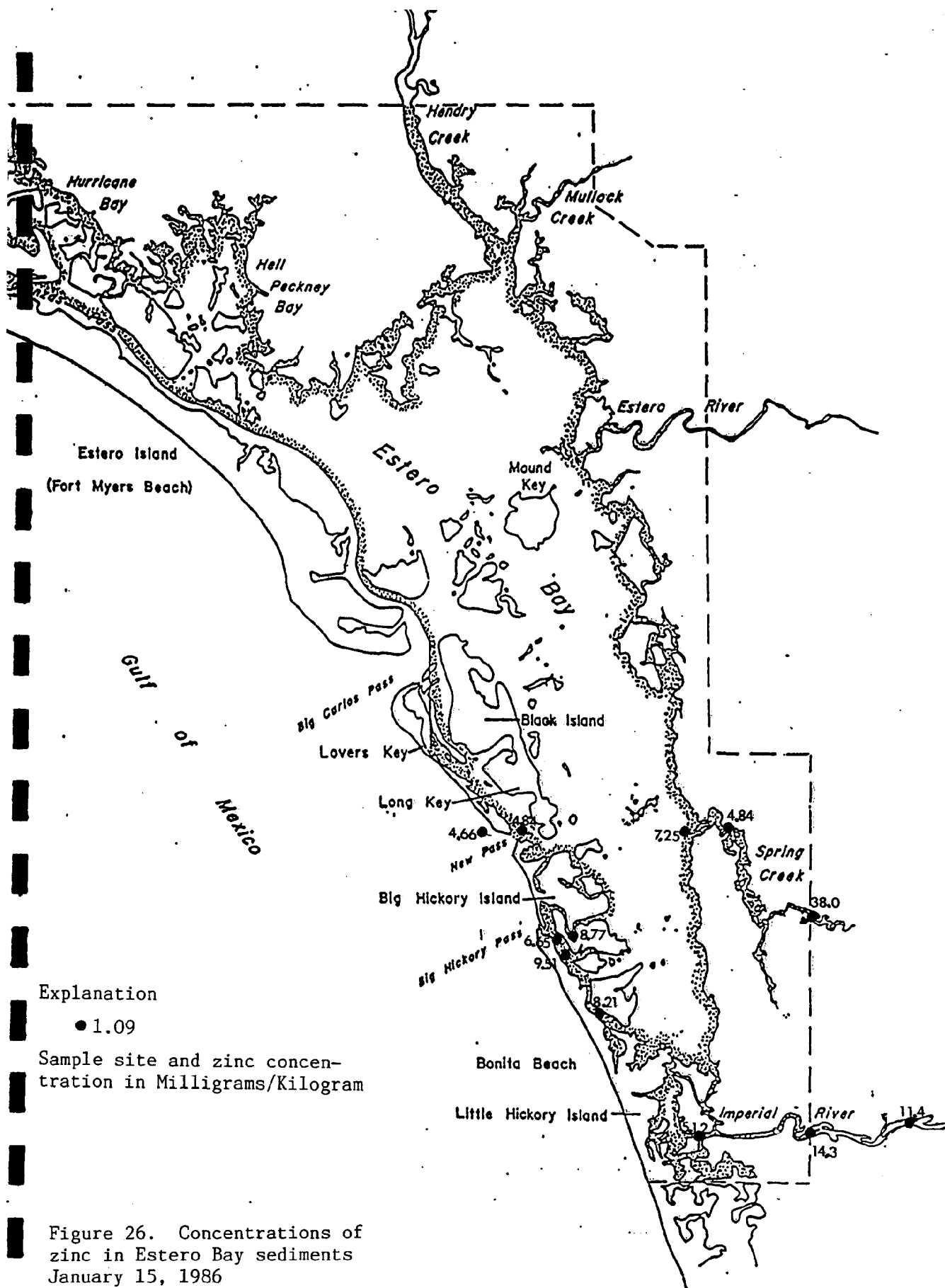












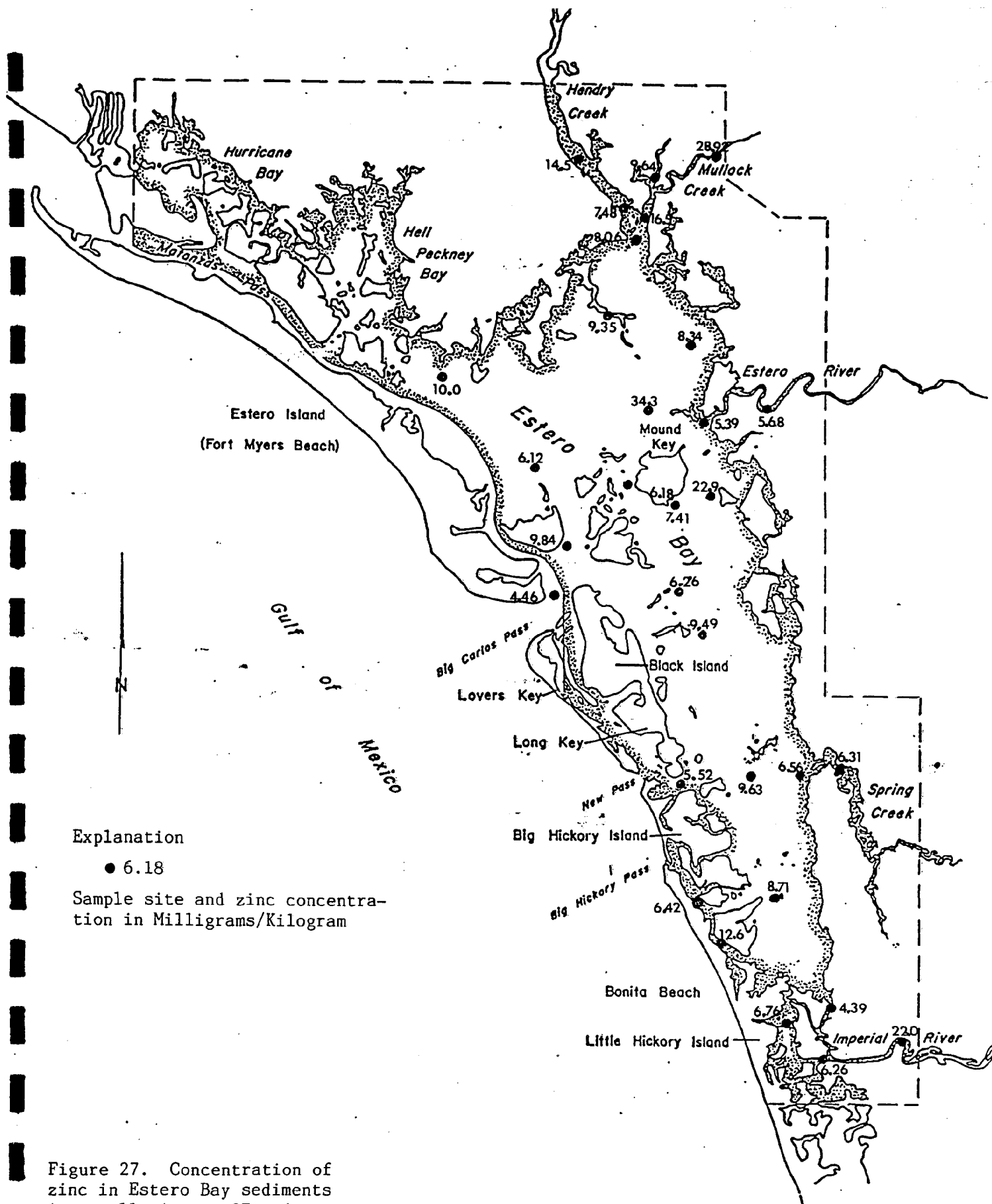


TABLE # 1

LOCATIONS AND SITE NUMBERS FOR TABLES TWO THROUGH FIVE

COLLECTION DATE: JANUARY 16, 1986

SITE #	LOCATION SITE
1	Outside New Pass
2	Inside New Pass
3	Mouth of Spring Creek
4	Spring Creek at Bonita Bay Gulf Course
5	Spring Creek at Subdivision
6	Big Hickory Bridge
7	Boat Dock in Big Hickory/Broadway Channel
8	Squaw Creek
9	Mouth of Imperial River
10	Imperial River at U.S. 41 Bridge
11	East End of Imperial River
12	Halfway Between U.S. 41 and Mouth of Imperial River
13	Hogue Channel

TABLE # 2

NUTRIENTS IN ESTERO BAY WATER COLUMN

COLLECTION DATE: JANUARY 16, 1986

	TOTAL NITROGEN	TOTAL KJELDHAL NITROGEN	NITRATE + NITRITE	TOTAL PHOSPHATE	ORTHO PHOSPHATE
SITE #	mg/l	mg/l	mg/l	mg/l	mg/l
1	0.69	0.69	<0.01	0.06	0.02
2	0.59	0.58	0.01	0.05	0.02
3	0.56	0.54	0.02	0.08	0.08
4	0.70	0.64	0.06	0.08	0.02
5	0.62	0.62	<0.01	0.04	0.04
6	0.64	0.63	0.01	0.05	0.02
7	0.52	0.51	0.01	0.09	0.09
8	0.54	0.54	<0.01	0.07	0.04
9	0.59	0.58	0.01	0.04	0.04
10	0.71	0.61	0.10	0.06	0.06
11	0.82	0.68	0.14	0.02	0.02
12	0.76	0.73	0.03	0.05	0.02
13	0.49	0.47	0.02	0.06	0.02

TABLE # 3

**PHYSICAL/CHEMICAL CHARACTERISTICS
IN THE ESTERO BAY WATER COLUMN**

COLLECTION DATE: JANUARY 16, 1986

SITE #	TEMPERATURE DEGREES CENTIGRADE			DISOLVED OXYGEN mg/l			SALINITY %		
	TOP	MID	BOTTOM	TOP	MID	BOTTOM	TOP	MID	BOTTOM
1	17	17	17	6.5	-	-	26	27	26
2	17	17	16	7.4	-	-	27	27	27
3	18	-	-	7.0	-	6.9	27	-	27
4	20	-	-	6.9	-	6.5	10	18	19
5	20	-	-	6.9	-	6.9	18	20	23
6	20	-	-	6.8	6.9	7.2	27	27	27
7	20	-	-	7.8	-	8.0	27	27	27
8	19	-	19	7.6	-	7.8	29	-	29
9	19	-	18	6.2	5.8	5.5	11	15	17
10	21	-	-	5.2	4.8	3.1	4	23	30
11	20	-	-	4.3	-	4.3	<1	-	<1
12	20	-	-	6.6	6.2	5.4	8	16	15
13	21	-	-	7.5	7.0	6.5	24	25	27

SITE #	TURBIDITY	CONDUCTIVITY	BOD ₅
	NTU	umhos/cm	mg/l
1	4.5	45,000	0.1
2	4.0	44,000	<0.01
3	2.1	40,500	0.1
4	1.0	15,500	0.5
5	1.2	29,000	0.6
6	1.2	42,500	<0.01
7	1.6	43,000	<0.01
8	3.7	44,500	0.4
9	1.0	18,000	0.4
10	1.0	6,750	0.3
11	0.73	550	<0.01
12	1.0	11,500	0.8
13	1.8	40,000	<0.01

TABLE # 4

BACTERIOLOGICAL DATA FROM ESTERO BAY
WATER COLUMN ANALYSIS

COLLECTION DATE: JANUARY 16, 1986

SITE #	TOTAL COLIFORM <u>colonies</u> 100 ml	FECAL COLIFORM <u>colonies</u> 100 ml	FECAL STREPTOCOCCUS <u>colonies</u> 100 ml
1	10	** 4	** 3
2	<10	<10	<10
3	<10	10	<10
4	40	40	<10
5	<10	<10	<10
6	*NR	<10	<10
7	20	40	<10
8	20	10	<10
9	20	100	10
10	10	210	10
11	<10	90	150
12	20	160	20
13	10	<10	<10

ALL SAMPLE SIZES 10 ML UNLESS NOTED.

* No Results- Laboratory accident

** Sample size 100 ml.

TABLE # 5

LOCATIONS AND SITE NUMBERS FOR TABLES SIX THROUGH EIGHT

COLLECTION DATE: JUNE 18, 1986

SITE #	LOCATION SITE
14	Big Carlos Pass
15	Mantanzas Pass
16	Mullock Pass
17	Spring Creek at mouth
18	New Pass
19	Imperial River at mouth

TABLE # 6

NUTRIENTS IN ESTERO BAY WATER COLUMN

COLLECTION DATE: JUNE 18, 1986

	TOTAL NITROGEN	TOTAL KJELDHAL NITROGEN	NITRATE + NITRITE	TOTAL PHOSPHATE	ORTHO PHOSPHATE
SITE #	mg/l	mg/l	mg/l	mg/l	mg/l
14	0.06	0.05	0.01	0.31	0.01
15	0.18	0.18	<0.01	0.32	0.02
16	0.37	0.37	<0.01	0.14	0.02
17	0.28	0.28	<0.01	0.33	0.01
18	0.12	0.12	<0.01	0.35	<0.01
19	0.40	0.40	<0.01	0.05	0.03

TABLE # 7

PHYSICAL/CHEMICAL CHARACTERISTICS
IN THE ESTERO BAY WATER COLUMN

COLLECTION DATE: JUNE 18, 1986

SITE #	DISOLVED OXYGEN mg/l			SALINITY ‰		
	TOP	MID	BOTTOM	TOP	MID	BOTTOM
14	5.5	8.0	9.0	30	30	31
15	4.5	6.2	7.2	29	29	30
16	3.8	3.8	3.8	32	34	36
17	4.5	4.5	4.5	30	30	30
18	6.8	7.0	7.2	28	32	31
19	5.5	5.6	5.8	19	20	22

SITE#	TURBIDITY	BOD ₅	pH
	NTU	mg/l	UNITS
14	2.3	3.1	7.8
15	3.0	2.5	7.8
16	3.1	6.9	8.0
17	3.0	2.9	7.9
18	2.1	3.8	8.0
19	2.6	1.2	7.9

TABLE # 8

BACTERIOLOGICAL DATA FROM ESTERO BAY
WATER COLUMN ANALYSIS

COLLECTION DATE: JUNE 18, 1986

SITE #	TOTAL COLIFORM <u>colonies</u> 100ml	FECAL COLIFORM <u>colonies</u> 100 ml	FECAL STREPTOCOCCUS <u>colonies</u> 100ml
14	* <10	* <1	* <1
15	<10	confluent	* 16
16	<10	* 3	* 10
17	30	* 8	* 18
18	<10	* 20	* 15
19	80	* 26	* <1

ALL SAMPLES SIZES 10 ML UNLESS NOTED.

* Sample size 100 ml.

TABLE # 9

LOCATIONS AND SITE NUMBERS FOR TABLES TEN THROUGH TWELVE

COLLECTION DATES: August 6, 1986 and August 7, 1986

SITE #	LOCATION SITE	DATE
20	MULLOCK CREEK	AUGUST 6, 1986
21	BIG CARLOS	AUGUST 6, 1986
22	NEW PASS	AUGUST 6, 1986
23	DIXON POINT	AUGUST 6, 1986
24	SPRING CREEK	AUGUST 6, 1986
25	ESTERO RIVER	AUGUST 6, 1986
26	IMPERIAL RIVER	AUGUST 7, 1986
27	IMPERIAL RIVER AT BEND	AUGUST 7, 1986
28	FISH TRAP BAY	AUGUST 7, 1986

TABLE # 10

NUTRIENTS IN ESTERO BAY WATER COLUMN

COLLECTION DATE: AUGUST 6, 1986 AND AUGUST 7, 1986

SITE #	TOTAL NITROGEN			TOTAL KJELDHAL NITROGEN			NITRATE + NITRITE		
	mg/l			mg/l			mg/l		
SITE #	TOP	MID	BOTTOM	TOP	MID	BOTTOM	TOP	MID	BOTTOM
20	1.46	-	-	1.42	-	-	0.02	-	-
21	0.48	-	-	0.48	-	-	<0.01	-	-
22	0.41	-	-	0.41	-	-	<0.01	-	-
23	0.99	1.30	1.14	0.94	1.24	1.08	0.05	0.06	0.06
24	0.59	-	-	0.58	-	-	0.01	-	-
25	0.77	-	1.01	0.77	-	1.00	<0.01	-	0.01
26	0.85	-	0.96	0.85	-	0.96	<0.01	-	<0.01
27	0.62	-	-	0.62	-	-	<0.01	-	-
28	0.99	-	-	0.99	-	-	<0.01	-	-

SITE #	AMMONIA			TOTAL PHOSPHATE			ORTHO PHOSPHATE		
	mg/l								
SITE #	TOP	MID	BOTTOM	TOP	MID	BOTTOM	TOP	MID	BOTTOM
20	0.03	-	-	0.07	-	-	0.05	-	-
21	<0.01	-	-	0.03	-	-	0.02	-	-
22	<0.01	-	-	0.01	-	-	0.01	-	-
23	0.09	0.11	0.12	0.03	0.04	0.03	0.07	0.04	0.04
24	0.07	-	-	0.01	-	-	0.01	-	-
25	<0.01	-	<0.01	0.01	-	<0.01	0.01	-	0.01
26	<0.01	-	<0.01	<0.01	-	0.01	0.02	-	0.01
27	<0.01	-	-	0.01	-	-	0.03	-	-
28	<0.01	-	-	0.01	-	-	0.01	-	-

TABLE # 11

**PHYSICAL/CHEMICAL CHARACTERISTICS
IN THE ESTERO BAY WATER COLUMN**

COLLECTION DATE: AUGUST 6, 1986 AND AUGUST 7, 1986

SITE #	TEMPERATURE DEGREES CENTIGRADE			DISOLVED OXYGEN mg/l			SALINITY %		
	TOP	MID	BOTTOM	TOP	MID	BOTTOM	TOP	MID	BOTTOM
20	30	-	-	5.6	-	-	18	-	-
21	30	-	-	5.4	-	-	31	-	-
22	30	-	-	5.4	-	-	31	-	-
23	30	30	30	4.2	5.2	4.6	20	20	21
24	29	-	-	5.4	-	-	33	-	-
25	30	-	30	7.7	-	10.1	29	-	30
26	31	31	30	5.6	-	4.4	17	18	18
27	-	-	-	9.2	-	-	-	-	-
28	-	-	-	6.5	-	-	-	-	-

SITE #	TURBIDITY NTU			BOD ₅ mg/l			pH UNITS		
	TOP	MID	BOTTOM	TOP	MID	BOTTOM	TOP	MID	BOTTOM
20	1.7	-	-	0.6	-	-	7.7	-	-
21	2.7	-	-	3.2	-	-	7.9	-	-
22	0.5	-	-	1.1	-	-	8.1	-	-
23	1.7	4.0	8.5	1.3	0.7	1.9	7.7	7.7	7.6
24	1.1	-	-	1.9	-	-	8.1	-	-
25	3.4	-	2.6	1.6	-	1.5	8.0	-	8.0
26	1.9	-	1.5	2.7	-	2.5	7.8	-	7.6
27	0.9	-	-	1.9	-	-	7.8	-	-
28	2.8	-	-	1.6	-	-	7.9	-	-

TABLE # 12

CONCENTRATIONS OF RHODAMINE DYE IN ESTERO BAY

COLLECTION DATE: JULY 17, 1986

LOCATION	TIME	INTRACID
		RHODAMINE WT DYE ug/l
Station # 1	12:44PM	0.3
Station # 1	1:37PM	0.3
Station # 1	2:33PM	0.3
Station # 1	4:25PM	0.3
Station # 2	12:43PM	<0.3
Station # 2	1:30PM	0.3
Station # 2	2:20PM	<0.3
Station # 2	4:22PM	<0.3
Station # 3	12:39PM	<0.3
Station # 3	1:28PM	<0.3
Station # 3	2:26PM	<0.3
Station # 4	11:20AM	<0.3
Station # 4	12:07PM	<0.3
Station # 4	1:11PM	<0.3
Station # 4	2:05PM	<0.3
Station # 4	3:04PM	1.3
Station # 4	4:21PM	1.3
Station # 5	11:15AM	0.3
Station # 5	12:04PM	0.3
Station # 5	1:08PM	4.3
Station # 5	2:03PM	1.3
Station # 5	3:02PM	1.0
Station # 5	4:19PM	0.5
Station # 6	11:14AM	0.3
Station # 6	12:03PM	22.8
Station # 6	1:06PM	3.1
Station # 6	2:01PM	2.0
Station # 6	3:00PM	0.8
Station # 6	4:17PM	0.5
Station # 7	11:13AM	<0.3
Station # 7	12:02PM	6.5
Station # 7	1:05PM	2.8
Station # 7	2:00PM	0.8
Station # 7	2:58PM	0.5
Station # 7	4:15PM	0.5
Station # 8	11:12AM	<0.3
Station # 8	12:00PM	<0.3
Station # 8	1:04PM	8.2
Station # 8	1:58PM	2.0
Station # 8	2:56PM	3.8
Station # 8	4:12PM	2.6
Station # 9	11:23AM	0.3
Station # 9	12:10PM	<0.3
Station # 9	1:14PM	<0.3

TABLE # 12 - Continued

CONCENTRATIONS OF RHODAMINE DYE IN ESTERO BAY

COLLECTION DATE: JULY 17, 1986

LOCATION	TIME	INTRACID
		RHODAMINE WT DYE ug/l
Station # 9	2:08PM	0.3
Station # 9	3:07PM	0.5
Station # 9	4:23PM	4.0
Station # 10	11:33AM	0.3
Station # 10	12:13PM	0.5
Station # 10	1:17PM	0.3
Station # 10	2:12PM	0.3
Station # 10	3:10PM	0.3
Station # 10	4:26PM	0.5
Station # 11	11:28AM	<0.3
Station # 11	12:18PM	<0.3
Station # 11	1:22PM	<0.3
Station # 11	2:16PM	<0.3
Station # 11	3:16PM	<0.3
Station # 11	4:40PM	<0.3
Station # 12	11:26AM	<0.3
Station # 12	12:16PM	<0.3
Station # 12	1:20PM	<0.3
Station # 12	2:14PM	<0.3
Station # 12	3:14PM	<0.3
Station # 12	4:30PM	<0.3
Station # 13	12:00PM	<0.3
Station # 13	1:00PM	<0.3
Station # 13	2:00PM	<0.3
Station # 13	4:07PM	<0.3
Station # 14	3:00PM	0.3
Station # 14	4:05PM	<0.3
Station # 15	2:56PM	0.3
Station # 15	4:00PM	<0.3
Station # 16	3:50PM	<0.3
Station # 19	3:35PM	<0.3
Station # 20	12:24PM	<0.3
Station # 20	1:15PM	<0.3
Station # 20	2:13PM	<0.3
Station # 20	4:12PM	<0.3
Station # 21	12:30PM	<0.3
Station # 21	1:20PM	<0.3
Station # 21	2:19PM	<0.3
Station # 21	4:15PM	<0.3
Station # 22	12:12PM	<0.3
Station # 22	1:12PM	<0.3
Station # 22	2:01PM	<0.3
Station # 22	4:10PM	<0.3
Station # 22	5:02PM	<0.3

TABLE # 12 - Continued

CONCENTRATIONS OF RHODAMINE DYE IN ESTERO BAY

COLLECTION DATE: JULY 17, 1986

LOCATION	TIME	INTRACID
		RHODAMINE WT DYE ug/l
Station # 23	12:10PM	<0.3
Station # 23	1:05PM	<0.3
Station # 23	2:05PM	<0.3
Station # 23	4:08PM	<0.3
Station # 23	5:00PM	<0.3
Station # 25	11:24AM	<0.3
Station # 25	12:11PM	<0.3
Station # 25	1:16PM	<0.3
Station # 25	2:09PM	<0.3
Station # 25	3:08PM	0.3
Station # 25	4:25PM	1.5
Mouth of Spring Creek		0.3
New Pass	3:45PM	<0.3
Big Carlos Pass	12:27PM	0.3
Big Carlos Pass	1:17PM	<0.3
Big Carlos Pass	2:15PM	<0.3
Big Carlos Pass	4:13PM	<0.3

TABLE # 13

CONCENTRATIONS OF RHODAMINE DYE IN ESTERO BAY

COLLECTION DATE: JULY 18, 1986

LOCATION	TIME	INTRACID
		RHODAMINE WT DYE ug/l
Station # 1	3:35PM	<0.3
Station # 2	3:35PM	<0.3
Station # 3	3:30PM	<0.3
Station # 4	4:00PM	0.8
Station # 5	4:02PM	1.3
Station # 6	4:05PM	1.3
Station # 9	3:56PM	0.3
Station # 10	3:51PM	0.3
Station # 11	3:00PM	<0.3
Station # 12	4:16PM	0.3
Station # 13	2:54PM	<0.3
Station # 14	2:51PM	<0.3
Station # 15	2:46PM	0.8
Station # 16	2:41PM	<0.3
Station # 17	2:33PM	<0.3
Station # 18	2:35PM	<0.3
Station # 19	3:10PM	<0.3
Station # 20	3:14PM	<0.3
Station # 21	3:21PM	<0.3
Station # 22	3:05PM	<0.3
Station # 23	2:58PM	<0.3
Station # 25	3:53PM	0.3
Big Carlos Pass	3:17PM	<0.3
New Pass	2:30PM	<0.3

TABLE # 14

CONCENTRATIONS OF RHODAMINE DYE IN ESTERO BAY

COLLECTION DATE: JULY 19, 1986

LOCATION	TIME	INTRACID
		RHODAMINE WT DYE ug/l
Station # 1	4:01PM	<0.3
Station # 2	3:55PM	<0.3
Station # 3	3:51PM	<0.3
Station # 4	2:00PM	0.3
Station # 5	2:03PM	0.5
Station # 6	2:06PM	0.3
Station # 7	2:08PM	0.5
Station # 8	2:11PM	0.5
Station # 10	3:19PM	0.3
Station # 11	3:24PM	<0.3
Station # 12	1:16PM	0.3
Station # 13	12:58PM	<0.3
Station # 14	12:52PM	0.3
Station # 15	12:50PM	0.3
Station # 16	12:35PM	<0.3
Station # 18	12:42PM	<0.3
Station # 20	1:37PM	<0.3
Station # 21	1:34PM	<0.3
Station # 22	1:09PM	<0.3
Station # 23	1:02PM	<0.3
Station # 25	1:30PM	0.3
Big Carlos Pass	1:40PM	<0.3
New Pass	12:32PM	<0.3

TABLE # 15

CONCENTRATIONS OF RHODAMINE DYE IN ESTERO BAY

COLLECTION DATE: SEPTEMBER 17, 1986

LOCATION	TIME	INTRACID
		RHODAMINE WT DYE ug/l
Station # 1	3:22PM	560
Station # 1	4:08PM	1.5
Station # 1	4:58PM	0.5
Station # 1	6:09PM	0.5
Station # 1	7:18PM	0.5
Station # 2	3:00PM	0.5
Station # 2	4:55PM	<0.5
Station # 2	5:30PM	<0.5
Station # 3	3:35PM	196
Station # 3	4:01PM	14.0
Station # 3	5:00PM	3.5
Station # 3	6:10PM	2.0
Station # 3	7:17PM	1.5
Station # 5	3:13PM	0.5
Station # 5	4:58PM	<0.5
Station # 5	5:34PM	<0.5
Station # 6	4:22PM	0.5
Station # 6	5:25PM	<0.5
Station # 6	6:31PM	<0.5
Station # 9	3:17PM	<0.5
Station # 9	5:02PM	<0.5
Station # 9	5:42PM	<0.5
Station # 12	3:21PM	0.5
Station # 12	5:06PM	<0.5
Station # 12	5:44PM	<0.5
Station # 13	4:12PM	<0.5
Station # 13	5:11PM	<0.5
Station # 13	6:21PM	15.0
Station # 14	4:08PM	34.0
Station # 14	5:08PM	7.5
Station # 14	6:18PM	<0.5
Station # 15	4:14PM	<0.5
Station # 15	5:15PM	22.0
Station # 15	6:24PM	7.5
Station # 16	3:25PM	0.5
Station # 16	5:00PM	<0.5
Station # 16	5:47PM	<0.5
Station # 17	3:35PM	0.5
Station # 17	5:20PM	<0.5
Station # 17	6:00PM	<0.5
Station # 19	4:03PM	<0.5
Station # 19	5:02PM	<0.5
Station # 19	6:13PM	<0.5
Station # 19	7:14PM	<0.5

TABLE # 15 - Continued

CONCENTRATIONS OF RHODAMINE DYE IN ESTERO BAY

COLLECTION DATE: SEPTEMBER 17, 1986

LOCATION	TIME	INTRACID RHODAMINE WT DYE ug/l
Station # 20	4:28PM	<0.5
Station # 20	5:55PM	<0.5
Station # 20	6:38PM	<0.5
Station # 21	4:18PM	<0.5
Station # 21	5:20PM	<0.5
Station # 21	6:27PM	14.5
Station # 23	5:46PM	<0.5
Station # 25	3:45PM	0.5
Station # 25	5:24PM	<0.5
Station # 25	6:03PM	<0.5
Big Carlos Pass	3:30PM	0.5
Big Carlos Pass	5:15PM	<0.5
Big Carlos Pass	6:55PM	<0.5
New Pass	5:41PM	<0.5

TABLE # 16

CONCENTRATIONS OF RHODAMINE DYE IN ESTERO BAY

COLLECTION DATE: SEPTEMBER 18, 1986

LOCATION	TIME	INTRACID
		RHODAMINE WT DYE ug/l
Station # 1	3:00PM	1.5
Station # 2	2:25PM	0.5
Station # 3	3:03PM	3.5
Station # 5	2:25PM	<0.5
Station # 6	2:49PM	<0.5
Station # 9	2:30PM	<0.5
Station # 12	2:32PM	<0.5
Station # 13	3:17PM	3.0
Station # 14	3:11PM	3.5
Station # 15	2:52PM	2.0
Station # 16	2:35PM	<0.5
Station # 17	2:15PM	<0.5
Station # 19	3:06PM	3.0
Station # 20	3:24PM	4.0
Station # 21	2:50PM	1.5
Station # 23	2:45PM	<0.5
Station # 25	2:20PM	<0.5
Station # 26	2:41PM	<0.5
Big Carlos Pass	2:10PM	<0.5
New Pass	3:32PM	<0.5

TABLE # 17

LOCATIONS AND SITE NUMBERS FOR TABLE EIGHTEEN

COLLECTION DATE: JANUARY 15, 1986

SITE #	SEDIMENT LOCATION SITE
1	Outside New Pass
2	Inside New Pass
3	Mouth of Spring Creek
4	Spring Creek at Bonita Bay Gulf Course
5	Spring Creek at Subdivision
6	Big Hickory Bridge
7	Boat Dock in Big Hickory
8	Squaw Creek
9	Mouth of Imperial River
10	Imperial River at U.S. 41 Bridge
11	East End of Imperial River
12	Halfway Between U.S. 41 and Mouth of Imperial River
13	Hogue Channel

TABLE # 18

TRACE METALS AND NUTRIENTS IN ESTERO BAY SEDIMENT

COLLECTION DATE: JANUARY 15, 1986

SITE #	*As mg/kg	Al mg/kg	Cd mg/kg	Cr mg/kg	Pb mg/kg	Hg mg/kg	Ag mg/kg	Cu mg/kg	Zn mg/kg
1	0.83	382	1.37	27.4	10.8	1.34	<0.5	2.48	4.66
2	0.77	684	0.89	5.71	4.43	<0.05	<0.5	0.83	4.84
3	1.30	1872	0.73	11.7	5.90	<0.05	<0.5	1.24	7.25
4	3.93	819	1.88	46.7	21.3	0.83	<0.5	8.97	38.0
5	0.82	1218	0.65	12.6	6.88	0.14	1.09	1.24	4.84
6	2.84	3252	1.37	21.7	13.3	0.05	1.09	3.73	9.51
7	1.09	2454	0.89	14.3	6.40	<0.05	<0.5	0.83	6.65
8	2.47	3750	1.21	27.4	11.8	0.13	1.09	3.31	8.77
9	0.59	732	0.40	10.9	3.94	0.07	<0.5	0.83	5.12
10	0.73	2394	0.80	15.4	13.8	<0.05	<0.5	3.31	11.4
11	0.55	529	0.49	5.71	2.95	0.15	<0.5	0.83	4.15
12	1.60	2964	0.73	20.9	11.3	0.18	<0.5	6.20	14.3
13	1.47	2646	1.13	16.6	9.83	<0.05	0.72	2.48	8.21

SITE #	TOTAL PHOSPHORUS mg/kg	TOTAL KJELDHAL NITROGEN mg/kg	% SOLIDS
1	0.026	0.006	78.2
2	0.012	0.005	75.7
3	0.022	0.023	68.1
4	0.050	0.168	20.3
5	0.008	0.016	73.2
6	0.061	0.048	55.7
7	0.026	0.015	72.6
8	0.045	0.047	55.6
9	0.022	0.011	75.0
10	0.029	0.020	66.5
11	0.001	0.003	78.7
12	0.032	0.070	52.7
13	0.043	0.042	62.7

* As - Arsenic
 Al - Aluminum
 Cd - Cadmium
 Cr - Chromium
 Pb - Lead
 Hg - Mercury
 Ag - Silver
 Cu - Copper
 Zn - Zinc

TABLE # 19

LOCATIONS AND SITE NUMBERS FOR TABLE TWENTY

COLLECTION DATE: AUGUST 11, 1986

SITE #	LOCATION SITE
29	Mouth of Spring Creek
30	Bar Outside Spring Creek
31	Half Way Between Spring Creek & New Pass
32	New Pass
33	East Mound Key
34	Big Carlos Pass
35	Big Hickory

TABLE # 20

TRACE METALS AND NUTRIENTS IN ESTERO BAY SEDIMENT

COLLECTION DATE: AUGUST 11, 1986

SITE #	* As mg/kg	Al mg/kg	Cd mg/kg	Cr mg/kg	Pb mg/kg	Hg mg/kg	Ag mg/kg	Cu mg/kg	Zn mg/kg
29	0.55	1615	0.80	10.3	3.64	<0.05	<0.5	1.30	6.31
30	0.68	1735	0.54	7.48	3.64	<0.05	<0.5	1.79	6.56
31	1.10	3330	0.93	16.4	9.09	<0.05	0.94	2.43	9.63
32	0.55	1165	0.54	7.95	3.64	<0.05	<0.5	0.98	5.52
33	1.12	2480	0.14	16.4	2.81	<0.05	<0.5	1.63	7.41
34	0.28	680	0.14	4.68	3.64	<0.05	<0.5	0.65	4.46
35	0.93	2015	0.54	11.7	7.28	<0.05	0.94	1.79	6.42

SITE #	TOTAL PHOSPHORUS mg/kg	TOTAL KJELDHAL NITROGEN mg/kg	% SOLIDS
29	0.021	0.020	67.4
30	0.016	0.030	73.2
31	0.034	0.037	68.7
32	0.015	0.035	63.5
33	0.032	0.046	77.2
34	0.017	0.014	71.3
35	0.032	0.045	78.0

* As - Arsenic
 Al - Aluminum
 Cd - Cadmium
 Cr - Chromium
 Pb - Lead
 Hg - Mercury
 Ag - Silver
 Cu - Copper
 Zn - Zinc

TABLE # 21

LOCATIONS AND SITE NUMBERS FOR TABLE TWENTY-TWO

COLLECTION DATE: AUGUST 27, 1986

SITE #	LOCATION SITE
14	COON KEY
15	STARVATION KEY
16	ESTERO
17	HORSE SHOE KEYS
18	NEEDMORE POINT
19	DIXON POINT
20	HENDRY CREEK I
21	HENDRY CREEK II
22	NORTH BRANCH MULLOCK CREEK
23	MULLOCK
24	MOUTH OF MULLOCK
25	NEEDMORE POINT II
26	BLACK KEY
27	MOUTH OF ESTERO
28	ESTERO II

TABLE # 22

TRACE METALS AND NUTRIENTS IN ESTERO BAY SEDIMENT

COLLECTION DATE: AUGUST 27, 1986

SITE #	*As mg/kg	Al mg/kg	Cd mg/kg	Cr mg/kg	Pb mg/kg	Hg mg/kg	Ag mg/kg	Cu mg/kg	Zn mg/kg
14	0.78	1145	0.93	8.88	5.14	<0.05	0.94	2.43	9.84
15	1.20	3390	0.40	20.6	8.18	<0.05	0.63	5.03	10.0
16	0.80	2040	0.54	11.7	2.34	0.09	<0.5	2.28	6.12
17	1.08	2650	0.93	14.0	7.28	<0.05	0.94	7.14	34.3
18	1.30	3610	0.93	19.2	12.73	<0.05	1.25	4.87	9.35
19	1.13	3255	0.66	15.9	9.09	0.08	0.63	3.57	8.06
20	0.73	2845	1.46	12.6	12.73	0.12	1.25	3.24	7.48
21	1.90	4590	0.80	30.4	6.08	0.16	0.63	6.17	14.5
22	1.05	3120	1.20	15.0	3.74	0.08	0.63	4.87	9.64
23	0.43	1740	2.53	13.1	2.81	0.15	<0.5	3.57	28.92
24	0.28	770	0.54	6.54	1.82	0.27	<0.5	1.46	16.5
25	0.85	3375	0.67	17.3	10.9	0.18	0.94	3.24	8.34
26	0.60	1960	0.67	11.7	3.64	<0.05	<0.5	2.28	22.9
27	0.30	1540	0.40	7.95	2.73	0.07	<0.5	2.11	5.39
28	0.33	1415	0.67	9.82	3.64	0.27	0.63	1.95	5.68

SITE #	TOTAL PHOSPHORUS mg/kg	TOTAL KJELDHAL NITROGEN mg/kg	% SOLIDS
14	0.020	0.018	76
15	0.031	0.076	62
16	0.021	0.015	73
17	0.027	0.061	71
18	0.036	0.072	52
19	0.025	0.063	64
20	0.031	0.091	64
21	0.035	0.187	44
22	0.021	0.091	58
23	0.012	0.025	64
24	0.007	0.011	77
25	0.028	0.108	60
26	0.026	0.031	72
27	0.016	0.040	70
28	0.019	0.043	68

* As - Arsenic
 Al - Aluminum
 Cd - Cadmium
 Cr - Chromium
 Pb - Lead
 Hg - Mercury
 Ag - Silver
 Cu - Copper
 Zn - Zinc

TABLE # 23

LOCATIONS AND SITE NUMBERS FOR TABLE TWENTY-FOUR

COLLECTION DATE: SEPTEMBER 3, 1986

SITE #	LOCATION SITE
36	Mound Key
37	Monkey Joe Key
38	Little Davis Key
39	Broadway Channel
40	Hogue Channel
41	Mouth of the North Branch of Imperial River
42	Mouth of the Imperial River
43	Bend of the Imperial River
44	Fish Trap Bay

TABLE # 24

TRACE METALS AND NUTRIENTS IN ESTERO BAY SEDIMENT

COLLECTION DATE: SEPTEMBER 3, 1986

SITE #	*As mg/kg	Al mg/kg	Cd mg/kg	Cr mg/kg	Pb mg/kg	Hg mg/kg	Ag mg/kg	Cu mg/kg	Zn mg/kg
36	1.03	2830	0.27	12.6	7.28	<0.05	<0.5	2.43	6.18
37	1.00	2380	0.40	12.2	6.37	<0.05	0.63	2.28	6.26
38	2.40	4060	0.80	21.5	10.9	0.11	0.63	4.22	9.49
39	0.95	2720	0.27	14.5	6.37	<0.05	<0.5	2.28	8.71
40	2.56	4635	1.07	28.0	14.5	<0.05	0.94	5.68	12.6
41	0.55	1955	0.14	10.3	6.37	0.14	0.63	2.28	6.26
42	0.15	890	0.80	5.1	4.55	<0.05	<0.5	1.63	4.39
43	1.48	4120	1.33	21.5	14.5	<0.05	<0.5	11.0	22.0
44	0.53	2115	1.46	10.3	9.09	<0.05	0.63	2.92	6.76

SITE #	TOTAL PHOSPHORUS mg/kg	TOTAL KJELDHAL NITROGEN mg/kg	% SOLIDS
36	0.030	0.047	68
37	0.025	0.034	70
38	0.037	0.038	58
39	0.031	0.035	70
40	0.019	0.128	49
41	0.037	0.030	73
42	0.006	0.023	76
43	0.034	0.148	36
44	0.031	0.040	71

* As - Arsenic
 Al - Aluminum
 Cd - Cadmium
 Cr - Chromium
 Pb - Lead
 Hg - Mercury
 Ag - Silver
 Cu - Copper
 Zn - Zinc

TABLE # 25

PESTICIDES AND PCBs IN ESTERO BAY SEDIMENT COMPOSITES

COLLECTION DATES: AUGUST 11-27, 1986/ SEPTEMBER 3, 1986

SAMPLE I.D.	MOISTURE % wet wt.	ALDRIN μg/kg	CHLORDANE μg/kg	DDT, PP' μg/kg	ENDRIN μg/kg
Hendry-Mullock Creek Composit	32.7	<1.46	<8.19	<1.46	<1.46
Estero River Composit	30.4	<1.42	<7.97	<1.42	<1.42
Spring Creek Composit	32.5	<1.47	<8.22	<1.47	<1.47
Imperial River Composit	41.1	<1.69	<9.45	<1.69	<1.69
Big Carlos Pass Composit	43.2	<1.69	<9.44	<1.69	<1.69

SAMPLE I.D.	LINDANE μg/kg	MIREX μg/kg	TOXAPHENE μg/kg	PCBS, TOTAL μg/kg
Hendry-Mullock Creek Composit	<1.46	<73.1	<173	<76.0
Estero River Composit	<1.42	<71.1	<168	<74.0
Spring Creek Composit	<1.47	<73.4	<173	<76.3
Imperial River Composit	<1.69	<84.4	<199	<87.8
Big Carlos Pass Composit	<1.69	<84.3	<199	<87.7

APPENDIX

QUALITY ASSURANCE FOR
WATER QUALITY, SEDIMENT ANALYSIS AND CIRCULATION PATTERNS OF
THE ESTERO BAY ESTUARINE SYSTEM, 1986

BY

KEITH A. KIBBEY

LEE COUNTY ENVIRONMENTAL LABORATORY
DIVISION OF ENVIRONMENTAL SERVICES
DEPARTMENT OF COMMUNITY DEVELOPMENT
LEE COUNTY BOARD OF COUNTY COMMISSIONERS

SEPTEMBER, 1986

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ESTERO BAY QUALITY ASSURANCE AND QUALITY CONTROL

1.0 QA OBJECTIVES FOR MEASUREMENT DATA1.1.1 INTRODUCTION

The purpose of this section is to provide qualitative and quantitative information that defines the quality of data collected to meet the goals of this estuary study.

The Lee County Environmental Laboratory is certified by Florida DHRS6(laboratory ID # 44031) and approved by the Florida DER laboratory no. EL 0028.

The primary goal of the sampling and analytical activities of the program was to determine the water and sediment quality in Estero Bay. The data generated will provide a "moment in time" perspective of the condition of the bay during both the dry and rainy seasons at the instant of sampling. Thus, the data collected will be used to formulate future monitoring activities and actions.

The goal of the reliability of the Program data was at the 95% confidence level. A goal of +/-10% for sampling precision was also established. Sampling precision will be evaluated using duplicate lab and field samples. The duplicate sample results helped to establish precision among different samples collected from the same site.

1.1.2 ACCURACY

Accuracy can be defined as how closely the observed values conform to the true value. This was accomplished by the recovery of analyte on spiked samples. These samples were prepared on a site specific basis to mimic the expected composition of the environment as closely as possible.

The accuracy for quantitative analyses is expressed in terms of percent recovery of the analyte. Percent recovery of analyte is determined as follows:

$$\% \text{ Analyte Recovery} = \frac{100 C}{A + B}$$

Where A = initial concentration of analyte in sample

B = quantity of analyte added to sample for spiking

C = final concentration of analyte in spiked sample

The analyte recovered data was compared to that generated in prior monitoring samples taken in the area of Lee County that have approximately the same matrix composition.

1.1.3 PRECISION

Precision measures the replicability and repeatability of results obtained from analyzing environmental samples. The analytical precision was monitored using results from laboratory and field duplicate samples.

Precision limits for each compound have been determined over the course of the program and average precision goals established. The precision is to be determined using the Industrial Coefficient (IC) and laboratory data which are used to establish Warning Limits for each analyte. The IC is calculated as follows:

$$IC = \frac{|A - B|}{A + B}$$

IC = Industrial Coefficient

A = First Duplicate Value

B = Second Duplicate Value

Warning Limits have established for each analyte to be tested in prior laboratory studies and will serve as a guide of Precision.

1.1.4 REPRESENTATIVENESS

The representativeness was ensured in two ways. First, all sampling was done in accordance with procedures as outlined in the Sampling Section of this report. These guidelines have been developed to ensure the consistency in sampling efforts and to help ensure that proper sampling and sample handling procedures are followed and proper equipment is used.

Additionally the monitoring was evaluated to determine if sample sites were adequate for determination of water and sediment quality in Estero Bay. Before sampling activities were undertaken the monitoring was thoroughly evaluated to ensure that monitoring sites had been properly spaced and designed. Properly selected monitoring sites provided data that was representative of Estero Bay.

1.1.5 COMPLETENESS

The completeness of the program was monitored by both qualitative and quantitative means. A qualitative assessment was made by comparing the objectives and procedures presented in the Project Plan. This assessment will determine on a qualitative level which objectives were met or not met.

Completeness was defined as the total number of samples taken for which acceptable analytical data are generated divided by the total number of samples collected multiplied by 100. The completeness goal for this Program is 95%. Site assessment planning is incorporating this figure to ensure that the Program is meeting objectives.

1.1.6 COMPARABILITY

Data generated during this Program used established and accepted analytical and sampling methods. Conformance with the development of precision and accuracy quality indicators ensured that the data generated under this Program was consistent and comparable with data generated under similar Programs. These quality indicators also ensure comparability of data with data generated in the past or in the future using acceptable sampling and analysis methods and appropriate quality indicators.

1.2 SAMPLING PROCEDURES

1.2.1 WATER COLUMN ANALYSIS SAMPLING PROCEDURES

Water column samples were taken in both dry and wet seasons to provide an overall yearly variation.

1.2.1.1 WATER COLUMN SAMPLE SITE SELECTION

The sites were chosen to obtain data on the quality of water entering and exiting Estero Bay. Sample sites were selected by use of aerial photographs, navigational charts, and visual observation by boat.

1.2.1.2 WATER COLUMN SAMPLE COLLECTION

Surface samples were collected one foot below surface; middle samples were collected halfway between top and bottom; and bottom samples were collected one foot from bottom, by grab sampling using a Wildco Model 1282 sampler. Sample containers were labeled with a permanent water proof marker denoting sample site, date, time, preservatives added, and parameter for analysis. All samples were placed on ice after collection and transported to the laboratory as soon as possible.

1.2.1.3 WATER COLUMN SAMPLE CONTAINERS

Sample containers must meet specific criteria for proper analytical results. The use of properly constructed and prepared containers is outlined below.

GENERAL PARAMETERS (nutrients, turbidity and pH)

Samples were placed in a new plastic disposable liter bottles. Bottles were cared for as follows:

Disposable containers are for a single time use and were not reused. They remained in their original shipping container which was a clean dust free environment. When a carton of sample containers were opened the sample containers were sealed with the appropriate lids. When the container for the sample container lids were opened, the lids were transferred to a plastic bag that was sealed to reduce contamination from dust and other contaminants. Sample containers were rinsed with the sample before filling.

BIOCHEMICAL OXYGEN DEMAND

Clean 300 ml BOD bottle, Wheaton "800" or equivalent prepared by cleaning with detergent, rinsing once with tap water and twice with laboratory pure water and allowed to drain.

BACTERIOLOGICAL

Six ounce glass bottles prepared in accordance with section 903.15, Standard Methods for the Examination of Water and Wastewater, 16th Edition, 1985.

DISSOLVED OXYGEN (Winkler)

Clean 300 ml BOD bottle, Wheaton "800" or equivalent prepared by cleaning with detergent, rinsing once with tap water and twice with laboratory pure water and allowed to drain. Manganous Sulfate, and Alkaline Azide solutions.

1.2.2 FLOW STUDY SAMPLING PROCEDURES

Intracid Rhodamine WT dye 20% was applied to the four tributaries of Estero Bay in two intervals. First dye was applied to the Hendry, Mullock Creek mouth, and the mouth of Spring Creek. The second dye application was to the mouths of the Estero River, and Imperial River. The dye was applied at high tide to allow the dye to be traced through the bay with the recessing tide. The dates and quantities of dye are as follows:

<u>LOCATION</u>	<u>DATE</u>	<u>AMOUNT OF DYE</u>
Hendry, Mullock Creek	July 17, 1986	10 gal
Spring Creek	July 17, 1986	2 gal
Estero River	September 17, 1986	5 gal
Imperial River	September 17, 1986	10 gal

1.2.2.1 FLOW STUDY SITE SELECTION

Sample sites were selected to allow following of the dye on an outgoing tide through the bay to the passes. Each sample site was marked with a buoy so that they could easily be returned to for subsequent samplings.

1.2.2.2 FLOW STUDY SAMPLE COLLECTION

After the dye was dispersed, surface grab samples were collected on an hourly basis until tidal change or dusk. Samples were also collected after 24 hours, and during the first application after 48 hours. The sample containers were first rinsed with sample, and then filled. Samples were taken approximately one foot below the surface. Sample containers were labeled with permanent water proof markers with the sample location, day, time, and parameters for analysis.

1.2.2.3 FLOW STUDY SAMPLE CONTAINERS

New plastic disposable one liter containers were used for the flow study and were cared for in the same manner as for "general parameters" in the water column sample container section. Sample containers were also rinsed with the sample before filling.

1.2.3 SEDIMENT ANALYSIS SAMPLING PROCEDURES

Initial sediment analysis were collected in January, 1986, to test sampling methods, laboratory methods and procedures. Since these analysis were performed with little difficulty they have been included in this report.

1.2.3.1 SEDIMENT ANALYSIS SITE SELECTION

Sediment sites were selected by use of the salinity gradient, aerial photographs and the results of the flow study. An emphasis was placed on areas around the 10-15% salinity line.

1.2.3.2 SEDIMENT ANALYSIS SAMPLE COLLECTION

Sediment grab samples were collected by scooping up the top layer (approximately one inch) of sediment with a polyethylene scoop. In water depths greater than 2.5 feet, samples were collected by diving and then scooped up in the same manner. Samples were brought up to the surface in a manner so to minimize sample loss, and placed in proper containers. Sample containers were then labeled with the sample location, date, time and type of sample, with waterproof markers. All samples were placed on ice and transported to the laboratory.

1.2.3.3 SEDIMENT ANALYSIS SAMPLE CONTAINERS

Once samples were out of the water the samples for nutrients and metals were placed in new plastic 1 liter bottles, prepared in the same manner as the water column general parameters.

The samples for pesticides were placed in borosilicate glass bottles which had been rinsed with methyl alcohol, baked in an oven and sealed with a teflon lined cap.

1.2.4 SAMPLE EQUIPMENT PREPARATION

Without proper sample container preparation the potential of contamination is at risk. Special procedures were followed in order to ensure the quality of each sample container. To ensure that samples are collected and transported with minimal contamination the greatest of care was used when preparing the sample containers for the samples. This ensured that the sample was not contaminated with material that had deposited residue in a container that could interfere with the analysis or promote erroneous results.

1.2.4.1 ICE CHESTS AND SHIPPING CONTAINERS

All ice chests and reusable shipping containers were washed with mild detergent (interior and exterior) and rinsed with tap water and air dried before storage.

1.2.4.2 VEHICLES AND BOATS

All vehicles used by laboratory personnel were washed (when possible) at the end of each field trip. This routine maintenance minimizes any chances of contamination of samples or equipment due to contaminated vehicles.

When the vehicles are used in conjunction with hazardous waste site sampling, or studies where pesticides, herbicides, organic materials or other toxic materials are known or suspect to be present, a thorough interior and exterior cleaning is performed at the conclusion of such events.

1.2.4.3 SAMPLERS

The Wildco model 1282 sampler is used to sample surface waters for a variety of analytes. Therefore it was thoroughly cleaned before sampling, between sample sites, and upon return to the laboratory.

The polyethylene scoop used for sediment samples was thoroughly rinsed between samples and thoroughly cleaned in the laboratory before use in the field.

1.2.5 SAMPLE PRESERVATION AND HOLDING TIMES

The method used to preserve samples is very critical to the stability of the analyte. For this reason very rigorous sample holding times and preservation methods were used to ensure the validity of data. A tabular summary of the sample holding requirements and holding times is provided below. The Lee County Environmental Laboratory follows the recommended storage time when possible and disposes of any samples which exceed maximum regulation times.

SAMPLE PRESERVATION METHODS AND HOLDING TIMES

<u>Determination</u>	<u>Container</u>	<u>Preservation</u>	<u>Maximum Storage</u>
BOD	P,G	Refrigeration	* 6 hr ~ 48 hr
Conductivity	P,G	Refrigeration	* 28 day ~ 28 day
Metals, general	P(A),G(A)	Add HNO ₃ <2	* 6 mos ~ 6 mos
Mercury	P(A),G(A)	HNO ₃ <2 and refrigerate	* 28 day ~ 28 day
Ammonia	P,G	Test ASAP or H ₂ SO ₄ <2 refrigerate	* 7 day ~ 28 day
Nitrate	P,G	Add H ₂ SO ₄ <2 refrigerate	* 48 hr ~ 48 hr
Nitrate + Nitrite	P,G	Test ASAP or refrigerate	* none ~ 28 day
Nitrite	P,G	Test ASAP or refrigerate	* none ~ 48 hr
Nitrogen	P,G	Refrigerate	* 7 day
Organic Kjeldahl		w/H ₂ SO ₄ <2	~ 28 day

Organic Compounds			
Pesticides	G(S), TFE-line cap	Refrigerate: add $\text{Na}_2\text{S}_2\text{O}_3$ if Cl_2 present	* 7 day ~ 7 day
Oxygen Dissolved	G, BOD bottle	Test ASAP	* 0.5 hr ~ 1.0 hr
Electrode			
Winkler		After acidification	* 8 hr ~ 8 hr
pH	P, G	Test ASAP	* 2 hr ~ 2 hr
Phosphate	G(A)	Refrigerate	* 48 hr ~ 48 hr
Salinity	G, wax seal	Test ASAP or seal	* 6 mos ~ none
Temperature	P, G	Test Immediately	
Turbidity	P, G	Store in Dark	* 24 hrs * 48 hrs

P = Plastic (polyethylene or equivalent)

G = Glass

G(A) or P(A) = rinsed with 1+1 HNO_3

G(B) = Glass borosilicate

G(S) = Glass, rinsed with organic solvents

* Recommended Storage Time

~ Regulatory Storage Time

1.2.6 SAMPLE SHIPPING

The holding times for certain analytes is critical and for this reason the carrier used to carry samples was selected to deliver the samples within 24 hours to the contract laboratory. The transport time to the Environmental Laboratory was the same day and processing began the same day or within 24 hours.

1.3 LABORATORY CALIBRATION AND ANALYTICAL PROCEDURES

The section consists of three sub-sections: the procedures used in the water column analysis; the procedures used in the Flow study; the procedures used in the sediment analysis.

1.3.1 WATER COLUMN ANALYSIS METHODOLOGY

Ammonia (EPA method 350.1 Colorimetric, Automated Phenate)

Total Phosphate (Ultramicro Semi-automated Method for the Simultaneous Determination of Total Phosphorus and Total Kjeldahl Nitrogen in Wastewaters by Jirka, et al of the U.S. EPA, Chicago Ill.)

Ortho Phosphate (Method 424 E, Standard Methods for the Examination of Water and Wastewater, 15th Edition, 1980.)

Total Nitrogen (TKN + NO_x)

Total Kjeldahl Nitrogen (Ultramicro Semi-automated Method for the Simultaneous Determination of Total Phosphorus and Total Kjeldahl Nitrogen in Wastewaters by Jirka, et al of the U.S. EPA, Chicago Ill.)

NO_x (EPA Method 353.2 Colorimetric, Automated, Cadmium Reduction)

pH (EPA Method 150.1 Electrometric)

Biochemical Oxygen Demand (EPA Method 405.1 Probe Method)

Dissolved Oxygen (EPA Method 360.1 Probe Method)
(EPA Method 360.2 Winkler Method)

Turbidity (EPA Method 180.1 Nephelometric)

Salinity (Method 210 A, Standard Methods for the Examination of Water and Wastewater, 16th Edition, 1985)

Conductivity	(EPA Method 180.1 Nephelometric)
Temperature	(EPA Method 170.1 Thermometric)
Total Coliform	(Method 909 A, Standard Methods for the Examination of Water and Wastewater, 16th Edition, 1985)
Fecal Coliform	(Method 909 C, Standard Methods for the Examination of Water and Wastewater, 16th Edition, 1985)
Fecal Streptococcus	(Method 910 B, Standard Methods for the Examination of Water and Wastewater, 16th Edition, 1985)

1.3.2 FLOW STUDY METHODOLOGY

Techniques of Water-Resources Investigations of the United States Geological Survey, chapter A12, Fluorometric Procedures for Dye Tracing by James F. Wilson, Jr. Testing was performed on a Turner Fluorometer. Standards were prepared from Bay water to counteract the interference of Phosphates in water.

1.3.3 SEDIMENT ANALYSIS METHODOLOGY

1.3.3.1 % SOLIDS IN SEDIMENT

Ten grams of sediment is placed in a tared foil pan and weighed on an analytical balance. The sample is then placed in a convection oven at 105°C for 18 hours. Cool the sample in a desiccator for 1 hour and then weigh on an analytical balance. The % solids is then determined.

1.3.3.2 TOTAL PHOSPHORUS IN SEDIMENT

Total Phosphorus in Sludge and Bottom Sediments

(Oxidizable and Hydrolyzable by Sulfuric Acid-persulfate Digestion-Autoclave)

A. Sample Preparation:

1. A sample of the sludge or sediment is dried at 105°C for 18 hours. A percent solids is determined. (see section 1.3.3.1)
2. Grind the dried sample with a mortar and pestle to a fine powder-discard rocks and foreign material.

B. Digestion Reagents:

1. Sulfuric Acid (H_2SO_4)- Add 25 ml concentrated H_2SO_4 to distilled water and dilute to 1 liter.
2. Potassium Persulfate ($K_2S_2O_8$)- Dissolve 4 gm $K_2S_2O_8$ in distilled water and dilute to 1 liter.

C. Digestion Procedure * :

1. Accurately weigh 0.1 g dried sample into a 50 ml erlenmeyer flask and add 5 ml PO_4 free water.
2. Add 5 ml of the sulfuric acid reagent (25 mg/l) and 10 ml of the $K_2S_2O_8$ reagent (4 g/l).
3. Cover the flasks with aluminum foil and autoclave for 30 minutes at 250°F and 15 psig.

Note - A set of standards (0.5, 1.0, 2.0, 4.0, 6.0, 8.0, 10, 15, and 20 mg/l PO_4 as P) are digested in the same manner as the samples. 5 ml of the standard is added to the 50 ml erlenmeyer flask and repeat steps 2 and 3. Prepare a blank by using 5 ml deionized water and repeating steps 2 and 3.

* All glassware used in this analysis should be washed with 1:1 HCL and rinsed with deionized water to remove phosphorus. This glassware should be used only for the determination of phosphorus. Do not use commercial detergents.

D. Analysis:

1. After digestion phosphorus is determined by the Automated Single Reagent Method, Method for Chemical Analysis of Water and Wastes, EPA, 1979, Method 365.1.
2. The Technicon wash water is 6.2-ml H_2SO_4 per liter.

E. Calculation:

1. Dry Weight Basis:

$$\frac{\text{ug/ml P (from standard curve)}}{\text{gm sample}} \times 5 \text{ ml} \times \frac{1000 \text{ mg}}{1000 \text{ Kg}} = \text{mg/kg P}$$

2. Wet Weight Basis:

$$\text{mg/kg P (Dry wt)} \times \% \text{ Solids (decimal fraction)} = \text{mg/Kg P (Wet Wt)}$$

References:

Standard Methods, 13th edition, 1971.

1.3.3.3 TOTAL KJELDAHL NITROGEN IN SEDIMENT

Total Kjeldahl Nitrogen (TKN) or Organic Nitrogen in Sediment.

A. Sample Preparation

1. To determine TKN only, use wet, settled sludge or sediment samples for the analysis.

B. Reagents

1. Digestion solution: Dissolve 134 g potassium sulfate, (K_2SO_4), in 650 ml ammonia-free water and 200 ml conc. sulfuric acid, (H_2SO_4). With stirring, add a solution of 2.0 g red mercuric oxide, (HgO), dissolved in 25 ml 6N H_2SO_4 . Dilute to 1 liter with ammonia-free water.
2. Sodium hydroxide-thiosulfate solution: Dissolve 500 g NaOH and 25 g $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ in ammonia-free water and dilute to 1 liter.
3. 2% Boric Acid Solution: Dissolve 20 g boric acid, H_3BO_3 in ammonia-free water and dilute to 1 liter.

C. Procedure

1. Take the residue in solution from the ammonia analysis, if available. Otherwise, weigh enough wet sample to give 0.1 to 0.2 g sample on a dry weight basis, place in micro-kjeldahl flask and add 50 ml ammonia-free water (used 1 g wet sample).
2. Add 8 ml of acid-sulfate-mercury digestion solution and digest until SO_3 fumes evolve. (If bumping is a problem add 2 or 3 Hengar selenized granules). Continue the digestion for 25-30 minutes after the evolution of the fumes. The solution should be colorless to pale yellow at this point. Cool to room temperature and stopper if not distilled immediately.
3. Steam out the distillation apparatus before use by placing 10 ml ammonia-free water and 10 ml hydroxide-thiosulfate solution in the flask. Steam out for 5-10 minutes. Samples maybe distilled consecutively after initial steam out.
4. Add 10 ml ammonia-free water prior to distillation.
5. Place a 50 ml Nessler tube containing 5 ml of 2% boric acid under the condenser with the tip of the condenser below the surface of the acid.
6. Place the kjeldahl flask on the distilling apparatus, add 10 ml hydroxide-thiosulfate solution and start steam into the flask by placing the stopper on the steam generator. Collect 35-40 ml of distillate.
7. Lower the receiving tube below the tip of the condenser and remove the stopper from the steam generator. Allow the condensate remaining in the condenser to drain into the receiving tube. Dilute to 50 ml with ammonia-free water.

D. Analysis

1. After distillation the ammonia is determined by the automated procedure, Methods for Chemical Analysis of Water and Wastes, EPA, 1979, Method 350.1. Technicon's wash water is 0.2% boric acid.

E. Calculations:

Dry weight basis:

$$\frac{\text{mg N found}}{(\% \text{ solids})(\text{g used})} \times \frac{\text{mls}}{\text{digestate}} = \text{mg/kg}$$

Wet weight basis:

mg/kg (dry weight) X % solids (decimal fraction) = mg/kg N (wet weight)

References:

Standard Methods, 13th edition, 1971

Methods for Chemical Analysis of Water and Wastes, EPA, 1979.

1.3.3.4 METALS IN SEDIMENT

In order to process a sediment sample in the laboratory for metal analysis a standard procedure of analysis must be followed. This includes the digestion, instrument setup, materials, reagents, supplies, and other pertinent information. This is typically covered in the Methods for Chemical Analysis of Water and Wastes, U.S.E.P.A.- 600/4-79-020. The instrumentation used in metal analysis is calibrated with the frequency and in the manner prescribed in the EPA reference 600/4-79-020.

1. Sediment Digestion for Metals

0.5 to 1.0g of sediment is weighed out into a teflon capped teflon digestion vial. (5ml of 48% HF) and 10 ml conc. HNO_3 are added and slowly heated to dryness (6-8 hours). 5 ml of conc. HNO_3 is added and the vials are allowed to sit for two hours. Beakers are then capped and digested on low heat for 48 hours. Caps are removed and nitric acid is then taken off (to near dryness) and five additional ml of HNO_3 and 1 ml of perchloric acid are added. The vials are heated until the white perchloric acid fumes subside. If necessary, additional increments of HNO_3 and perchloric acid are added to complete digestion. The sediment is then brought up with 1 ml conc. HNO_3 . Dilute to final volume of 25 ml with DI water. Analyze by atomic absorption.

2. Specific Methods for Analysis after digestion.

Arsenic	(EPA Method 206.3 AA-Hydride)
Aluminum	(EPA Method 202.1 AA-Flame)
Cadmium	(EPA Method 213.2 AA-Furnace)
Chromium	(EPA Method 218.3 AA-Furnace)
Lead	(EPA Method 239.2 AA-Furnace)
Mercury	(EPA Method 245.5 cold vapor)
Silver	(EPA Method 272.2 AA-Furnace)
Copper	(EPA Method 220.1 AA-Furnace)
Zinc	(EPA Method 289.1 AA-Furnace)

3. Calculations

After the concentration of the digestion solution the following equation is used to convert from ug/l to mg/Kg

$$\frac{\mu\text{g/ml} \times \text{dilution}}{\text{sample wt. (g)}} = \text{ppm} = \text{mg/Kg}$$

1.3.3.5 ORGANICS IN SEDIMENT

Organic analysis were performed by Environmental Science and Engineering, Inc. (ESE) of Gainseville, Florida. Mr. Jeff D. Shamis was the project coordinator for ESE.

The samples were analyzed in accordance with procedures specified in EPA Method 8080, Test Methods for Evaluating Solid Waste, SW-846, July, 1982.

ESE is certified by The Florida DHRS (certification number 82138) and is excepted by The Florida DER (Lab # EL 0024).

1.4 DATA REDUCTION VALIDATION AND REPORTING

The analytical methods used for each analyte typically illustrate the procedure for collecting, calculating, and reducing the test data to a useable form. This is outlined in the prior section of this document.

1.4.1 DATA VALIDATION

This section describes the methods by which the data was interpreted, validated, and reported. Procedures are indicated by major measurement parameters for sampling, analysis and overall program evaluations. The overall data flow for sampling and analysis is shown in Figure 2 of this document. The significance of outliers was used to quantify and improve the the relative significance of the data generated.

1.5 INTERNAL QUALITY CONTROL

This section is to outline the methods of quality control used in the laboratory. This typically includes the use of spiked samples, duplicate samples, and replicate samples. Spikes and blanks are used to check the analytical accuracy and the duplicate analysis is used to establish the analytical precision. Inorganic matrix spikes and duplicate analyses were performed at a frequency of one per analytical batch or one per twenty samples, whichever frequency is greater.

1.5.1 FIELD QUALITY CONTROL CHECKS

The following quality control checks are to be used for sampling operations:

1. Trip blanks
2. Field duplicates

The above was performed at a frequency of not less than one per sample event or one per twenty samples, whichever was more frequent. This was used to establish the precision and accuracy of the field collection procedures.

1.5.2 PERFORMANCE AND SYSTEM AUDITS

This auditing procedure is typically carried out by the laboratory's participation in both the DER performance audit sample program, the DHRS Laboratory Certification Program, and EPA quality assurance proficiency samples. This in addition to the PE check samples that are routine run by the laboratory using EPA known samples that are procured from the USEPA. This allows the laboratory to compare routine test data with that of that regulatory agencies and other laboratories that participate in these programs.

1.5.3 PREVENTATIVE MAINTENANCE PROCEDURES

Maintenance schedules for all sampling and analytical equipment will be in accordance with the recommendations of the equipment manufacturers. Routine operations, such as septum replacement, oil change, etc. was performed by laboratory personnel as required. Specialized inspection and maintenance of major equipment items was performed by factory representatives.

1.5.4 SPECIFIC ROUTINE PROCEDURES TO ASSESS DATA PRECISION, ACCURACY AND COMPLETENESS

1.5.4.1 STATISTICAL PROCEDURES FOR PRECISION

Precision is a measure of the mutual agreement among individual measurements of the same parameter under prescribed, similar conditions. Replicability is the variability (within batch) among repeated independent determinations of the same measurement parameter by a laboratory at the same time under identical conditions.

The following statistical procedures were used to calculate the precision attributes for this program:

Replicability

$x_{i_1}, x_{i_2} = \text{data pair}$

$\bar{x}_i = \text{average of replicate pair}$

$x_a = \text{arithmetic mean of all replicate pair averages}$

$s(x_a) = \text{the standard deviation of the replicate pair averages}$

$k = \text{the number of replicate pair sets}$

$N = \text{number of samples averaged}$

$R_i = |x_{i_1} - x_{i_2}|$

$$\bar{R} = \frac{\sum_{i=1}^N R_i}{N}$$

$$\bar{x}_i = \frac{x_{i_1} + x_{i_2}}{2}$$

$$k$$

$$x_a = \frac{\sum_{i=1}^k \bar{x}_i}{k}$$

$$s(x_a)^2 = \frac{\sum_{i=1}^k (\bar{x}_i - x_a)^2}{k}$$

$$s(x_a) = \sqrt{s(x_a)}$$

1.5.4.2 STATISTICAL PROCEDURES FOR ACCURACY

Accuracy is the degree of agreement between the true value of a parameter being measured and the average of observations made according to the test method. The following statistical procedures were used for accuracy determinations:

A_i = percent of accuracy

O_i = observed concentration

T_i = true concentration

N = number of check samples measured

\bar{A} = average accuracy

$$A_i = \frac{O_i}{T_i} \times 100$$

$$\bar{A} = \frac{\sum_{i=1}^N A_i}{N}$$

$$s_A = \frac{\sum_{i=1}^N (A_i - \bar{A})^2}{N-1}$$

$$s_A = \sqrt{(s_A^2)}$$

Recovery is an attribute related to accuracy which applies to analysis of performance using spiked performance evaluation samples. Statistical procedures for analysis of recovery of recovery are as follows:

R_i = analyte recovery (percent)

O_i = observed values

B_i = background values

T_i = true values

N = number of samples

\bar{A} = average recovery

s_R = standard deviation of recoveries

$$R_i = \frac{(O_i - B_i)}{T_i} \times 100$$

$$\bar{R} = \frac{\sum_{i=1}^N R_i}{N}$$

$$s_R^2 = \frac{\sum_{i=1}^N (R_i - \bar{R})^2}{N-1}$$

$$s_R = \sqrt{(s_R^2)}$$

1.5.4.3 COMPLETENESS

Completeness was evaluated by comparing the number of samples acquired for analysis to the number of samples analyzed.

$$\text{Completeness, \%} = \frac{\text{Number of samples analyzed}}{\text{Number of samples acquired}} \times (100)$$

1.5.4.4 CONTROL CHARTS

Program and laboratory performance with respect to precision and accuracy was compared to existing control charts for safe drinking water. Means and standard deviations were calculated using the procedures outlined above for central lines and control limits respectively. Warning and control limits for means was established at 2s and 3s respectively.

1.6 QUALITY ASSURANCE RESULTS

Parameter	Average Accuracy (% Recovery)	Average Precision (IC)
<u>METALS IN SEDIMENT</u>		
Arsenic	90.7	0.05
Aluminum	95.7	0.04
Cadmium	89.7	0.02
Chromium	90.7	0.05
Lead	89.3	0.08
Mercury	91.8	0.00
Silver	90.0	0.21
Copper	97.3	0.07
Zinc	95.0	0.03
<u>FLOW STUDY</u>		
Rhodamine WT Dye	95.7	0.03
<u>WATER COLUMN</u>		
Ammonia Nitrogen	100.9	0.05
Nitrite Nitrogen	104.5	0.13
Nitrate Nitrogen	102.7	0.06
Total-Phosphate	96.7	0.24
Total Kjeldahl	104.6	0.39

COMPLETENESS 99%

ENVIRONMENTAL SCIENCE & ENGINEERING, INC. QC SUMMARY

The following data represent the complete summary of qc run for the accompanying samples. Only representative analytes are routinely controlled.

QC Summary Report For Sample List LCEL01 STORET#METHOD 70320#1
Parameter Name: MOISTURE, %WET WT

BATCH 33683 ANALYST: MARGARET CARTER ANALYSIS DATE: 09/08/86

REPL. SAMPLE	FOUND #1	FOUND #2	DIFFERENCE
RP1#DCC120#30	10.9	11	.1
RP1#VSP-1#2	21.6	20.7	.9
RP1#VSP-1#17	35.6	35.6	0
RP1#VSP-1#31	21.1	20.7	.4
RP1#VSP-1#45	23.3	21.2	2.1
RP1#VSP-1#49	2.3	2.3	0
RP1#GART15#3	3.2	3.3	.1

AVERAGE STANDARD MATRIX RECOVERY =	NA	STANDARD DEVIATION=	NA
AVERAGE SAMPLE MATRIX RECOVERY =	NA	STANDARD DEVIATION=	NA
AVERAGE REPL. SPIKE % DIFFERENCE =	NA	STANDARD DEVIATION=	NA

QC Summary Report For Sample List LCEL01
Parameter Name: DDT,PP', UG/KG-DRY

STORET\METHOD 39301*EC

BATCH 33808 ANALYST: BRAD WEICHERT ANALYSIS DATE: 09/15/86

QUAD CALIBRATION CURVES:

CURVE ID: 39301*EC*1

CONC= .274239554 + .000814498*RESP + -3.6496*RESP**2

SEE= .645218832 .000040863 3.1598

DATE: 09/15/86 CORR. COEFF= .99994 DETECTION LMT: 1

CURVE ID: 39301*EC*2

CONC= .517661928 + .009812636*RESP + -1.9935*RESP**2

SEE= 2.4956 .001009579 .653750471

DATE: 09/18/86 CORR. COEFF= .99983 DETECTION LMT: 25

SPIKE SAMPLE	% RECOVERY	REL. % DIFFERENCE
SPM*LCEL01*5	74.1838	
SP1*NONE*1	68.5613	
SP2*NONE*1	70.2906	2.4909
SPM*NWS2SE*26	70.9125	

AVERAGE STANDARD MATRIX RECOVERY =	69.4259	STANDARD DEVIATION=	1.2228
AVERAGE SAMPLE MATRIX RECOVERY =	72.5482	STANDARD DEVIATION=	2.3132
AVERAGE REPL. SPIKE % DIFFERENCE =	2.4909	STANDARD DEVIATION=	0

QC Summary Report For Sample List LCEL01
Parameter Name: ALDRIN, UG/KG-DRY

STORET\METHOD 39333*EC

BATCH 33808 ANALYST: ERAD WEICHERT ANALYSIS DATE: 09/15/86

QUAD CALIBRATION CURVES:

CURVE ID: 39333*EC*1

CONC= .005421977 + .000501119*RESP + 1.9379*RESP**2

SEE= .154609766 .000006282 3.1852

DATE: 09/15/86 CORR. COEFF= 1.00000 DETECTION LMT: 1

CURVE ID: 39333*EC*2

CONC= .035726029 + .003376516*RESP + -1.2296*RESP**2

SEE= .071596857 .000014081 .041616835

DATE: 09/18/86 CORR. COEFF= 1.00000 DETECTION LMT: 1

SPIKE SAMPLE	% RECOVERY	REL. % DIFFERENCE
SPM*LCEL01*5	87.2862	
SP1*NONE*1	83.2877	
SP2*NONE*1	83.4212	.1602
SPM*NWS25E*26	83.9456	

AVERAGE STANDARD MATRIX RECOVERY =	83.3544	STANDARD DEVIATION=	.0944
AVERAGE SAMPLE MATRIX RECOVERY =	85.6179	STANDARD DEVIATION=	2.3593
AVERAGE REPL. SPIKE % DIFFERENCE =	.1602	STANDARD DEVIATION=	0

QC Summary Report For Sample List LCEL01
Parameter Name: CHLORDANE, UG/KG-DRY

STORET\METHOD 39351\EC

BATCH 33808 ANALYST: BRAD WEICHERT ANALYSIS DATE: 09/15/86

QUAD CALIBRATION CURVES:

CURVE ID: 39351\EC*1

CONC= + *RESP + *RESP**2

SEE=

DATE: 09/15/86 CORR. COEFF= DETECTION LMT: 5.6

CURVE ID: 39351\EC*2

CONC= .666901982 + .011590707*RESP + -4.1783*RESP**2

SEE= 4.4352 .001042213 19.2761

DATE: 09/18/86 CORR. COEFF= .99995 DETECTION LMT: 6

QC Summary Report For Sample List LCEL01
Parameter Name: ENDRIN, UG/KG-DRY

STORET*METHOD 39393*EC

BATCH 33808 ANALYST: ERAD WEICHERT, ANALYSIS DATE: 09/15/86

QUAD CALIBRATION CURVES:

CURVE ID: 39393*EC#1

CONC= .006550498 + .000735217*RESP + -5.3652*RESP**2

SEE= .068439817 .000004025 2.9408

DATE: 09/15/86 CORR. COEFF= 1.00000 DETECTION LMT: 1

CURVE ID: 39393*EC#2

CONC= -.179084835 + .004970472*RESP + -2.1679*RESP**2

SEE= .365320213 .000107724 .481375281

DATE: 09/15/86 CORR. COEFF= 1.00000 DETECTION LMT: 1

SPIKE SAMPLE	% RECOVERY	REL. % DIFFERENCE
SPM*LCEL01*5	92.1045	
SP1*NONE*1	78.1735	
SP2*NONE*1	46.1669	51.4822
SPM*NWS2SE*26	89.3114	

AVERAGE STANDARD MATRIX RECOVERY = 62.1702 STANDARD DEVIATION= 22.6321

AVERAGE SAMPLE MATRIX RECOVERY = 90.708 STANDARD DEVIATION= 1.975

AVERAGE REPL. SPIKE % DIFFERENCE = 51.4822 STANDARD DEVIATION= 0

BATCH COMMENT: 1 OF 2 CONTROL SPIKES BELOW RECOVERY GOAL. BATCH JUDGED IN
CONTROL WITH THE OTHER CONTROL SPIKE VERY GOOD, GOOD MATRIX
SPIKES, AND NO DETECTION OF PESTICIDES IN THE SAMPLES.

QC Summary Report For Sample List LCEL01
Parameter Name: BHC,G(LINDANE), UG/KG-DRY

STORET*METHOD 39783*EC

BATCH 33806 ANALYST: BRAD WEICHERT ANALYSIS DATE: 09/15/86

QUAD CALIBRATION CURVES:

CURVE ID: 39783*EC#1

CONC= $-.266144725 + .000490687*RESP + 2.2066*RESP**2$

SEE= $.590626890 .000024693 1.314015536$

DATE: 09/15/86 CORR. COEFF= .99995 DETECTION LMT: 1

CURVE ID: 39783*EC#2

CONC= $.061662279 + .003776692*RESP + -1.8712*RESP**2$

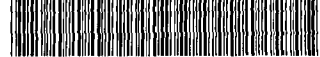
SEE= $.123835200 .000026266 .083453704$

DATE: 09/18/86 CORR. COEFF= 1.00000 DETECTION LMT: 1

SPIKE SAMPLE	% RECOVERY	REL.% DIFFERENCE
SPM*LCEL01#5	85.6616	
SP1*NONE#1	85.4272	
SP2*NONE#1	83.5797	2.1863
SPM*NWS2SE#26	85.5526	

AVERAGE STANDARD MATRIX RECOVERY =	84.5034	STANDARD DEVIATION=	1.3064
AVERAGE SAMPLE MATRIX RECOVERY =	85.6071	STANDARD DEVIATION=	.0771
AVERAGE REPL. SPIKE % DIFFERENCE =	2.1863	STANDARD DEVIATION=	@

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